

THE OWENS COLLEGE COURSE
OF
PRACTICAL
ORGANIC CHEMISTRY

BY
JULIUS B. COHEN, PH.D., F.C.S.
ASSISTANT LECTURER ON CHEMISTRY, OWENS COLLEGE, MANCHESTER, &c.

London :
MACMILLAN AND CO.,
AND NEW YORK.
1887.

The Right of Translation and Reproduction is Reserved.

RICHARD CLAY AND SONS,
LONDON AND BUNGAY.

PREFACE.

WE have much pleasure in recommending this little book to the notice of advanced students of chemistry. Any course of Practical Organic Chemistry leading up to original work in this branch of the science, must mainly consist in the careful preparation of a well-selected series of organic compounds. Dr. Julius Cohen has in the following pages collected such a series, and we feel confident that this work, filling, as it does, a lacuna in our English chemical literature, will prove most useful alike to the Professors, Demonstrators, and Students of our science.

HENRY E. ROSCOE.

C. SCHORLEMMER.



Digitized by the Internet Archive
in 2025

AUTHOR'S PREFACE.

THE author wishes it to be clearly understood that the book is only intended for the use of students who are undergoing or have undergone a substantial course of instruction in the principles of organic chemistry. Its primary purpose is that of a laboratory guide, and its use should be supplemented by reference to some of the large text-books, as well as to the original sources of chemical literature mentioned at the head of each preparation. For convenience of immediate reference, and in the hope of emphasising some of the important facts, an Appendix is added, containing some notes explanatory of the theoretical importance of the reactions involved in the preparations.

The preparations have been selected and arranged with the object of illustrating the relationship existing between certain groups of organic bodies, as well as their characteristic reactions.

The usual arrangement of fatty before aromatic compounds has been reversed for the reason that those of the latter, which have been selected, offer fewer difficulties to the beginner.

For valuable assistance given him by Professor Schorlemmer and Professor Smithells, to Professor Emil Fischer, to whom he is indebted for the details of some of the preparations, to Dr. W. H. Perkin, junior, and others, the author's best thanks are due.

TO THE STUDENT.

Before beginning the preparation, read the recent literature on the subject, reference to which will be found at the head of the preparation, and refer to it in your text-book. A few explanatory notes are added in the Appendix. Weigh the quantities prescribed on a rough chemical balance. Note the yield of the product in each case, and compare it with the quantity theoretically obtainable.

OWENS COLLEGE, *April*, 1887.

CONTENTS.

PART I.

	PAGE
PURIFICATION OF ALCOHOL	3
Absolute alcohol	3
Boiling-point determination	3
Methylated spirit	4
PURIFICATION OF ETHER	5
Pure ether	5
Methylated ether	6
PURIFICATION OF BENZENE	7
Pure benzene	7
50 per cent. and 90 per cent. benzene	8
Fractional distillation	8-12

CONTENTS.

		PAGE
PREPARATION	I. Monobromobenzene	12
"	II. Ethyl benzene	15
"	III. Nitrobenzene	17
"	IV. Aniline	19
"	V. Acetanilide	22
	Melting-point determination . . .	23
"	VI. Ortho- and para-nitracetanilide .	26
"	VII. Meta-dinitrobenzene	28
"	VIII. Meta-nitraniline	29
"	IX. Diethylaniline	31
"	X. Para-nitrosodimethylaniline . .	33
"	XI. Para-nitrosophenol	35
"	XII. Potassium benzene sulphonate .	37
"	XIII. Phenol	39
"	XIV. Anisol	41
"	XV. Ortho- and para-nitrophenol . .	42
"	XVI. Picric acid	45
"	XVII. Phenolphthalein	46
"	XVIII. Quinone	48
"	XIX. Hydroquinone	50
"	XX. Benzyl chloride	51
"	XXI. Benzaldehyde	53
"	XXII. Benzyl alcohol	55
"	XXIII. Toluic acid	56

CONTENTS.

xi

PAGE

PREPARATION	XXIV.	Ortho- and para-oxybenzaldehyde	59
„	XXV.	Acetophenone	62
„	XXVI.	Benzoin	64
		Benzil	65
„	XXVII.	Benzilic acid	66
„	XXVIII.	Benzoyl chloride	67
		Benzamide	68
„	XXIX.	Thiocarbanilide	69
„	XXX.	Phenyl thiocarbimide	70
		Triphenylguanidine	71
„	XXXI.	Benzonitril	72
„	XXXII.	Diazobenzene nitrate	73
		Iodobenzene	75
„	XXXIII.	Diazoamidobenzene	76
„	XXXIV.	Amidoazobenzene	78
„	XXXV.	Phenylhydrazine	79
„	XXXVI.	Cinnamic acid	81
„	XXXVII.	Hydrocinnamic acid	82
„	XXXVIII.	Quinoline	84
„	XXXIX.	Mesitylene	85
„	XL.	Mesitylenic acid	87
		Uvitic acid	87
„	XLI.	Triphenylmethane	90
„	XLII.	Ethyl benzoate	93

PART II.

		PAGE
PREPARATION	XLIII. Ethyl bromide	95
	Specific gravity determination	97-100
"	XLIV. Ether	100
"	XLV. Chloroform	103
"	XLVI. Ethyl orthoformate	104
"	XLVII. Potassium ethyl sulphate . . .	106
"	XLVIII. Propionitril	107
"	XLIX. Propionic acid	109
"	L. Ethylene dibromide	110
"	LI. Ethylene alcohol	113
"	LII. Ethylene chlorhydrin	114
"	LIII. Succinic acid	117
"	LIV. Dibromsuccinic acid	118
"	LV. Acetaldehyde	120
"	LVI. Acetyl chloride	124
"	LVII. Acetic anhydride	126
"	LVIII. Acetamide	127
"	LIX. Methylamine hydrochloride . .	128
"	LX. Ethyl acetate	130
"	LXI. Ethyl acetoacetate	132
"	LXII. Ethyl acetosuccinate	134

CONTENTS.

xiii

PAGE

PREPARATION	LXIII.	Monochloracetic acid	136
„	LXIV.	Glycocoll	137
„	LXV.	Ethyl monochloracetate . . .	139
„	LXVI.	Diethyl malonate	140
„	LXVII.	Ethylmalonic acid	142
„	LXVIII.	Trichloracetic acid	144
„	LXIX.	Diethyl oxalate	145
„	LXX.	Ethyl diethyl-oxyacetate . . .	147
„	LXXI.	Formic acid	148
„	LXXII.	Allyl alcohol	151
„	LXXIII.	Allyl iodide	153
„	LXXIV.	Propenyl tribromide	155
„	LXXV.	Tricarballic acid	156
„	LXXVI.	Glyceric acid	157
„	LXXVII.	Iodpropionic acid	159
„	LXXVIII.	Propenyl dichlorhydrin . . .	160
„	LXXIX.	Urea	162
„	LXXX.	Thiourea	163
„	LXXXI.	Alloxantin	164
„	LXXXII.	Alloxan	166

ABBREVIATIONS.

- ANN. CH. PHARM. = Liebig's *Annalen der Chemie und Pharmacie*, vol. i. (1832), 8 supplements, 4-5 vols. annually.
- ANN. CH. PHYS. = *Annales de Chimie et de Physique*, 1st series (1789-1815), 2nd series (1816-1840), 3rd series (1841-1863), 4th series (1864-1873), 5th series, from 1873. 3 vols. annually.
- BER. = *Berichte der deutschen chemischen Gesellschaft*, vol. i. (1868). 1 vol. annually.
- BERZ. JAHRESB. = *Jahresbericht über die Fortschritte der physischen Wissenschaften*, J. Berzelius (1821-1847).
- BULL. SOC. CHIM. = *Bulletin de la Société Chimique de Paris*, under the title of *Répertoire de Chimie pure et appliquée*, vols. i.-v. (1858-1863). Since then under the first title. 2 vols. annually.
- CHEM. SOC. J. ... = *Journal of the Chemical Society*, vols. i.-xxviii. (1848-1875). 1 vol. annually; since 1876 (vols. xxix.-xxx.) 2 vols. annually.
- COMPT. REND. ... = *Comptes rendus des Séances de l'Académie des Sciences*, vol. i. (1835). 2 vols. annually.
- JAHRESB. = *Jahresbericht über die Fortschritte der Chemie* (Ricker), vol. i. (1847-1848). 1 vol. annually.

- JOURN. PRAKT. CH. = *Journal für praktische Chemie*, vols. i.-cviii. (1834-1869). 3 vols. annually. Neue Folge since 1870. 2 vols. annually.
- MONATSH. = *Monatshefte für Chemie*, vol. i. (1880). 1 vol. annually.
- PHIL. MAG. = *Philosophical Magazine*, vol. i. (1798).
- PHIL. TRANS. = *Philosophical Transactions of the Royal Society*, vol. i. (1665). 1 vol. annually.
- PROC. ROY. SOC. = *Proceedings of the Royal Society*, vol. i. (1847). 1 to 2 vols. annually.
- POGG. ANN. = *Poggendorff's Annalen der Physik und Chemie*, 160 vols. (1824-1877). Neue Folge, edited by J. Wiedemann, vols. i.-ii. (1877). 3 vols. annually.
- ZEITSCHR. F. CH. = *Zeitschrift für Chemie* (Beilstein, Fittig, and Hübner), vols. i.-vii. (1865-1871).

PRACTICAL ORGANIC CHEMISTRY.

PART I.

PART I.

I. PURIFICATION OF ALCOHOL.

Commercial absolute alcohol (ethyl alcohol), obtained by rectifying crude spirits of wine over quicklime, is seldom free from water. The alcohol may be further dehydrated by allowing it to stand for twenty-four hours in a flask half filled with freshly-burnt and coarsely powdered quicklime, and then distilling off on the water-bath. The apparatus for this purpose is represented in Fig. 1. The alcohol if pure boils constantly at 78° – 79° . The temperature is indicated by a thermometer inserted through the cork in one limb of a T-piece *a*, the other end of which is fitted vertically into the flask. The side limb is bent through a small angle and passes into the inner tube of the condenser. The bulb of the thermometer is adjusted below this side limb, so that it is heated by the ascending vapours of the boiling liquid.

BOILING-POINT DETERMINATION.—A correct determination of the boiling-point of a liquid is made with a standard thermometer, correction being made for barometric pressure, and, if

necessary, for the thread of mercury which projects above the vessel. For the latter the formula given in a foot-note on p. 25 may be used. It is, however, preferable to increase the length of the distilling tube, so that the mercury column is entirely immersed in the vapour.

Methylated spirit is a mixture of 9 parts spirit of wine and 1 part purified wood-spirit, and contains

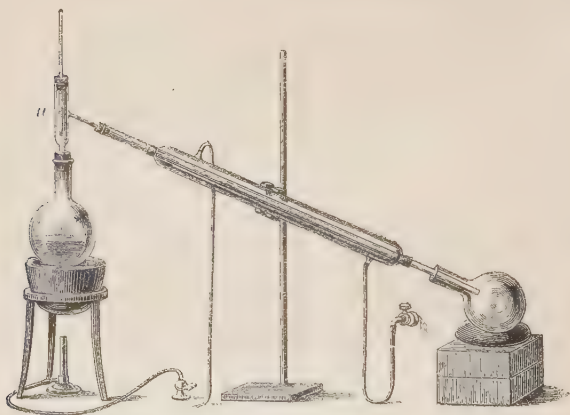


FIG. 1.

in addition to ethyl and methyl alcohols, water, fusel oil, acetaldehyde, and acetone. It may be freed from aldehyde and acetone by boiling with 3—4 per cent. solid caustic potash on the water-bath with reflux condenser for an hour (Fig. 2), and then distilling off on the water-bath. It is freed from water

by distilling once or twice over fresh quicklime in the manner described. Purified methylated spirit may generally replace the more expensive ethyl alcohol as a solvent.¹

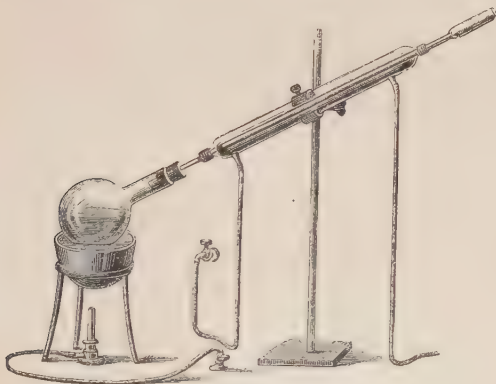


FIG. 2.

2. PURIFICATION OF ETHER.

Pure commercial ether, prepared from ethyl alcohol (p. 100) and free from water and alcohol, has no action upon sodium. Its specific gravity at 15° is .702. If there is a slight evolution of hydrogen on

¹ COMMERCIAL METHYL ALCOHOL, obtained by purifying wood spirit, is now prepared nearly free from acetone, and, after purification with potash and lime, may also replace ethyl alcohol as a solvent.

introducing a small piece of sodium, on adding more sodium the action soon ceases and the ether is then anhydrous. If, on the other hand, the action is brisk, the ether must be left in contact with small pieces of fused calcium chloride for twenty four hours, poured off, and a few thin slices of sodium introduced. The vessel is then closed by a cork, through which an open chloride of calcium tube is inserted to allow any hydrogen to escape and to prevent absorption of moisture.

Methylated ether, prepared from methylated spirit by the same process as the ethyl ether, consists of a mixture of diethyl, ethyl methyl, and dimethyl ethers, and contains usually alcohol and water. For extracting substances from aqueous solutions the ether may be employed without further purification. To free it from alcohol it is shaken up repeatedly with small quantities of water. The water dissolves out the alcohol and forms a layer at the bottom of the liquid, and is drawn off by means of a separating funnel. The ether, separated as carefully as possible from water in this way, is dehydrated over fused calcium chloride, and sodium, as described above. It should not give the *iodoform* reaction. (See Appendix.)

N.B.—*In cases where ether is used great care should be taken, that no flame is in the neighbourhood of the liquid.*

3. PURIFICATION OF BENZENE.

Pure commercial benzene, obtained from coal-tar naphtha, should distil within one degree (80° — 81°) and solidify completely when cooled to 0° . Other tests are as follows: Shaken with concentrated sulphuric acid for a few minutes, the acid should not darken, and a drop of bromine water should not be immediately decolorised. A single distillation over a few small pieces of sodium which absorb any traces of water, is usually a sufficient purification. If the benzene impart a brown or black colour to sulphuric acid it must be repeatedly shaken with about 20 per cent. of the acid until the latter becomes only slightly yellow on standing. This is done in a stoppered separating funnel, and after shaking for a minute the mixture is allowed to settle and the lower layer of acid drawn off. The benzene is then shaken two or three times with water to free it from acid, carefully separated from the aqueous layer and allowed to remain in contact with pieces of fused calcium chloride until the liquid becomes clear. It may then be frozen in ice, and any liquid (carbon bisulphide, paraffins) carefully drained off and the benzene finally distilled over sodium.

Commercial 50 per cent. and 90 per cent. benzene are mixtures of benzene and larger or smaller quantities of its higher boiling homologues, viz. toluene (110°) and the xylenes (137° — 143°). The benzene may be separated by *fractional distillation*.

It is often possible to separate almost completely by a single distillation two liquids occurring together in a mixture when their boiling-points lie widely apart. The more volatile liquid first passes over, the temperature suddenly rises, and the higher boiling liquid distils. Thus, in the separation of ethyl benzene (p. 16 from its ethereal solution, the ether (B. P. 35°) distils off almost completely at the temperature of the water-bath, leaving behind the ethyl benzene (B. P. 134°). It is otherwise when a liquid consists of a mixture of bodies boiling at temperatures not very far removed from one another, especially in the case of homologous compounds such as occur in petroleum and coal-tar naphtha. One distillation suffices only to produce very partial separation of the different substances, a portion of the less volatile liquid being carried over in the first distillate together with the more volatile body, the temperature gradually rising throughout the distillation. In order to effect separation of the several substances in a case of this kind recourse is had to the method of fractional distillation.

The liquid is distilled in a round-bottomed flask over wire-gauze or, better, in a fusible metal bath with a thermometer so placed that the temperature of the vapour of the boiling liquid is indicated, *i.e.* with the bulb just below the side tube of the fractionating column (Fig. 3). As the temperature gradually rises the distillate, which passes over between every

3° , 5° , or 10° , as the case may require, is collected in separate flasks. These separate portions are called fractions. Each of these fractions when submitted to a second distillation is usually found to begin to boil at a temperature lower than that indicated in the first instance, so that it is possible in this way to subdivide

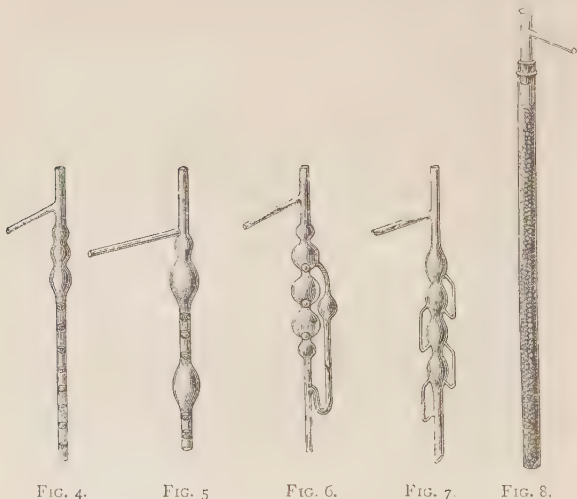


FIG. 3.

Distilling apparatus with Würtz's fractionating column.

each fraction into a portion of lower boiling-point, and a portion of higher boiling-point, and the process is continued until certain of the fractions have a nearly constant boiling-point. If the vapour, which rises from the boiling liquid to be fractionated, undergoes slow cooling before reaching the condenser, the less

volatile portion carried upwards with the more volatile vapour is partially condensed. If this is allowed to flow back into the flask only the lower boiling portion passes into the condenser, and the separation is more



The apparatus of Linnemann (Figs. 4 and 5) contains a series of wire gauze cups, that of Glinsky (Fig. 6) and Lebel and Henninger (Fig. 7) has in addition a side tube, down which condensed vapour flows. Hempel's apparatus (Fig. 8) is a long wide glass tube filled with small glass beads.

rapid and effective. Several forms of apparatus have been devised on this principle (*see* Figs. 4—8).¹

¹ The apparatus of Linnemann and of Hempel have been found to give very good results with low boiling liquids (Kreis; *Ann. Ch. Pharm.* 224, 259).

Fit up an apparatus as shown in Fig. 3 with fractionating column, and distil 200 c.c., 50 per cent. or 90 per cent. benzene at a regular speed, so that the drops falling from the end of the condenser may be readily counted. Collect the distillate between every five degrees in separate flasks. Redistil each of these fractions in order, adding the next to the residue of the previous one in the distilling flask, and collect portions boiling below 85° and above 105° between every two or three degrees. Redistil the fractions below 85° and above 105° as before, and collect between every two degrees. It will be found that by repetition of the process the liquid is gradually separated into two large fractions consisting chiefly of benzene and toluene and a number of smaller intermediate fractions. The following table gives the volume in c.c. and the boiling points of the fractions obtained by this method from 200 c.c. 50 per cent. benzene, each table denoting a complete series of fractionations.

I

A. $71.5-85^{\circ}$	B. $85-90^{\circ}$	C. $90-95^{\circ}$	D. $95-100^{\circ}$	E. $100-105^{\circ}$	F. $105-110^{\circ}$	G. $110-115^{\circ}$	Residue.
19 c.c.	53 c.c.	26 c.c.	15 c.c.	13 c.c.	17 c.c.	21 c.c.	33 c.c.

II.

	A'. below 79°.	B'. 79-81°	C'. 81-85°	D'. 85-105°	E'. 105-108°	F'. 108-110°	Residue.
A.	5 c.c.	...	...	...	...	...	...
Added B.	...	42 c.c.	(10 c.c.*)	...	...	...	...
Added C.	...	...	(2 c.c.*)	...	...	...	...
Added D. E.	...	...	...	50 c.c.	...	...	...
Added F.	...	...	...	...	(11 c.c.*),	...	...
Added G.	...	...	...	...	...	22 c.c.	42 c.c.
*Refrac- tioned C'.	...	12 c.c.	7 c.c.	...	...	...	...
F'	...	...	...	...	6 c.c.	5 c.c.	...
	5 c.c.	54 c.c.	7 c.c.	50 c.c.	6 c.c.	27 c.c.	42 c.c.

The fraction 79°—81° is further purified in the manner already described.

PREPARATION I.

MONOBROMOBENZENE, C_6H_5Br .

LITERATURE.—Couper (1857), Ann. Ch. Pharm. 104, 225; Fittig (1862), Ann. Ch. Pharm. 121, 361; Riche (1862), Ann. Ch. Pharm. 121, 360. Michaelis (1876) Ann. Ch. Pharm. 181, 289.

50 grms. benzene.
105 grms. bromine.

Fifty grms. benzene and 105 grms. bromine are poured into a round-bottomed flask of about 300 c.c. capacity fastened by a stout piece of india-rubber tubing to the end of a condenser, which projects into the neck of the flask (Fig. 9). The mixture is gently

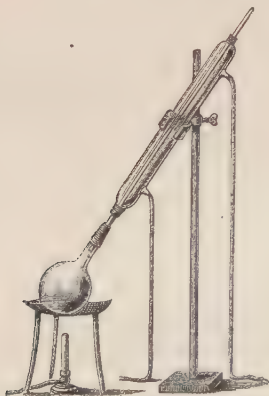


FIG. 9.

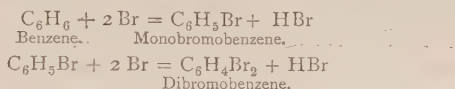
heated over wire-gauze with a small flame* until the evolution of hydrobromic acid fumes from the top of the condenser have nearly ceased. The product,

* Denotes that the operation must be conducted in a draught cupboard or in the open air.

which has a deep red colour, is allowed to cool and dry air aspirated through it in order to drive off dissolved hydrobromic acid. The unattacked benzene is then distilled off on the water-bath. On the addition of dilute caustic soda solution to the residual liquid monobromobenzene settles to the bottom of the vessel as a heavy oil. On shaking in a stoppered separating funnel the excess of bromine is dissolved out, and the liquid loses gradually its red colour. The oil is allowed to settle and carefully drawn off from below. It is shaken repeatedly with water in a similar manner, and finally dehydrated over a few pieces of fused calcium chloride.

The clear liquid decanted from the calcium chloride is distilled over wire-gauze, a thermometer being inserted into the neck of the flask. A small quantity of benzene passes over and the temperature then rises rapidly, the chief portion of liquid boiling between 150° and 155° , which is separately collected. The colourless distillate is nearly pure bromobenzene. Small quantities of para-dibromobenzene, which are formed in the above reaction, remain in the distilling flask, and solidify on cooling. This compound may be dissolved out with ether or warm alcohol, from which it crystallises on evaporation. It is to be obtained pure by one or two recrystallisations from alcohol (prismatic crystals, melting point 89° , boiling point 219°).

Reaction (expressed in the form of equation):



Properties.—Colourless liquid; boiling-point 154° — 155° ; specific gravity 1.5176 at 0° .

PREPARATION II.



LITERATURE.—Fittig (1864), *Ann. Ch. Pharm.* 131, 303; Fittig, König (1867), *Ann. Ch. Pharm.* 144, 277.

60 grms. bromobenzene.

52 „ ethyl bromide (see p. 95).

26.5 „ sodium.

A quantity of pure ether (about twice the volume of the mixed phenyl and ethyl bromides) is poured into a round-bottomed flask, about 1 litre capacity, connected with a reflux condenser. 26.5 grms. clean sodium cut into thin slices are added to the ether, and when all evolution of hydrogen has ceased the flask is immersed in a vessel of water which is cooled by the addition of ice (Fig. 10). The mixture of 60 grms. bromobenzene and 52 grms. ethyl bromide, both of which must be perfectly anhydrous, is poured

into the flask. The reaction is allowed to commence spontaneously, the fact being indicated by the sodium becoming darker in colour and sinking to the bottom of the vessel. Although the flask is allowed to remain in the outer vessel, and is cooled by water and ice, the heat evolved in the reaction often causes the ether

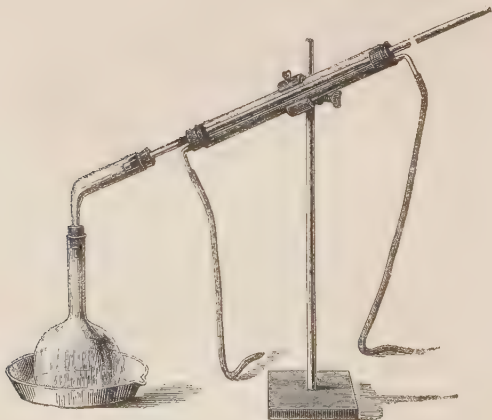
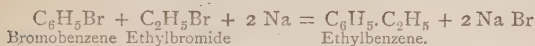


FIG. 10.

to boil. The flask is, therefore, not removed from this vessel until the reaction is over. The ether is then distilled off on the water-bath, and the ethyl benzene is driven over as quickly as possible by using a naked flame, the vessel being first gently heated round the sides, and finally more strongly from below, until no

more liquid distils. The distillate, containing ether and benzene, is rectified, and the portion boiling at 132° — 135° collected.



Properties.—Colourless liquid; b. p. 134° ; sp. gr. $\cdot 8664$ at $22\cdot 5^{\circ}$.

PREPARATION III.

NITROBENZENE, $\text{C}_6\text{H}_5\text{NO}_2$.

LITERATURE.—Mitscherlich (1834), Ann. Ch. Pharm. 12, 305; Mulder (1840), Journ. prakt. Ch. 19, 375.

50 grms. benzene.

100 „ conc. nitric acid, sp. gr. $1\cdot 42$.

150 „ conc. sulphuric acid.

A well-cooled mixture of 100 grms. conc. nitric acid, and 150 grms. conc. sulphuric acid is slowly added from a tap-funnel to 50 grms. benzene contained in a flask of about $\frac{1}{2}$ litre capacity.* The contents of the flask are meanwhile *well shaken*. Nitrous fumes are evolved, and a considerable amount of heat developed. Care must be taken that the temperature does not exceed 40° — 50° by immersing the flask, if necessary, in cold water. The nitrobenzene separates out as a brown, oily layer on the surface of the acid

liquid. When the acid has all been added—an operation which lasts about half an hour—the mixture is heated for about twenty minutes on the water-bath to 60° — 70° and again well shaken. The contents of the flask on cooling are poured into a stoppered-separating funnel, the lower layer of acid removed, and the nitrobenzene washed free from acid by shaking repeatedly with water, then with dilute carbonate of

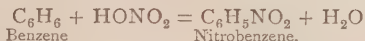


FIG. 11.

soda solution, and again with water, the oil being each time withdrawn from the *bottom* of the vessel. The nitrobenzene, separated as carefully as possible from water, is allowed to stand over a few pieces of fused calcium chloride, and shaken occasionally until the liquid is perfectly clear.

The yellow liquid is decanted from the calcium chloride and distilled in a dry distilling flask, the side tube of which fits into a long, straight, condensing

tube (Fig. 11). At first a little benzene passes over, the temperature then rises, and the nitrobenzene distils at 204° — 207° , and is separately collected. The brown residue contains a small quantity of dinitrobenzene.



The function of the sulphuric acid is that of a dehydrating agent, taking up the water formed in the reaction.

Properties.—Light yellow liquid, smelling of bitter almonds; b. p. 206° — 207° ; sp. gr. 1.208 at 15° ; it solidifies at $+3^{\circ}$; insoluble in water; soluble in alcohol, ether, benzene, and conc. nitric acid.

PREPARATION IV.



LITERATURE.—Unverdorben (1826), Pogg. Ann. 8, 397; Runge (1834), Pogg. Ann. 31, 65; Fritzsche (1847), Ann. Ch. Pharm. 36, 84, and 39, 76; Zinin (1842), Ann. Ch. Pharm. 44, 283; Hofmann (1844), Ann. Ch. Pharm. 47, 37; Roussin (1861), Jahresb. 643.

60 grms. nitrobenzene.

95 „ tin (granulated or in powder).

350 „ conc. hydrochloric acid.

Sixty grms. nitrobenzene and 95 grms. granulated or powdered tin, are placed in a flask of about 1 litre

capacity connected with a reflux condenser. 350 grms. conc. hydrochloric acid are gradually added in small quantities, the amount being regulated by the reaction, which should proceed steadily. If the contents of the flask begin to boil up violently, the flask is cooled in water until the reaction has somewhat slackened. When nearly the whole of the tin has dissolved, the flask is transferred to the water-bath and heated for about half an hour. The liquid now contains no drops of oil and the smell of nitrobenzene should have disappeared. The contents of the flask, which on cooling solidify to a crystalline mass (a double salt of stannic chloride and aniline hydrochloride) are diluted with water, and strong caustic soda solution added until the stannic oxide, which is first precipitated, nearly redissolves. The aniline, which separates out as a dark-coloured oil, is distilled with steam. For this purpose the apparatus shown in Fig. 12 is employed. The mixture containing the aniline is placed in a flask (*B*) connected with a condenser, the flask being somewhat inclined to prevent liquid spirting into the neck and being carried over into the receiver. The flask is heated gently on a sand-bath. Steam is passed in from a second flask (*A*) containing water by a tube which reaches below the level of the liquid to be distilled. A straight vertical tube open at both ends and dipping below the level of the water, prevents the aniline mixture rushing back when the lamp is withdrawn

from under the boiling water. Aniline and water collect in the receiver, the former as an almost colourless oil. When no further condensation of oil is observed, the distillation is discontinued and the oil extracted from the distillate by shaking the liquid in a separating funnel two or three times with small quantities (50 c.c.) of ether. The ethereal solution separated as far as possible from water is further

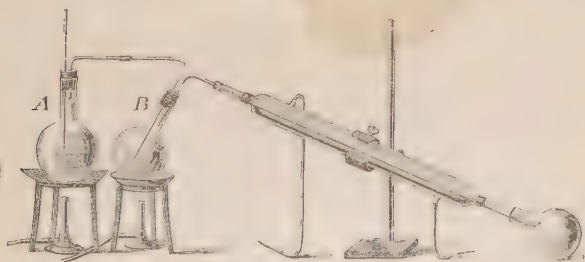


FIG. 15.

dehydrated by adding a few pieces of solid caustic potash. The clear liquid is decanted into a distilling flask and the ether distilled off on the water-bath, until nothing more passes over. The residue is distilled over wire gauze. Aniline distils at 181° — 182° and has usually a faint amber colour.



Properties.—Colourless, highly refracting liquid, which quickly darkens in colour; b. p. 182° ; sp. gr. 1.0265 at 15° . With bleaching powder solution a drop of the oil gives a blue colour; on heating a few drops of the base with a little alcoholic potash and a drop of chloroform in a test-tube phenylcarbamine is formed, a substance possessing an intolerable smell (Hofmann's reaction for primary amines).

PREPARATION V.

ACETANILIDE, $C_6H_5NO = C_6H_5.NH.CO.CH_3$.
(*Phenylacetamide*.)

LITERATURE.—Gerhardt (1853), Ann. Ch. Phys. (3) 37, 328; G. Williams (1864), Chem. Soc. J. 2, 106.

25 grms. aniline.

25 „ glacial acetic acid.

Twenty-five grms. aniline and 25 grms. glacial acetic acid are mixed in a retort or flask of about 250 c.c. capacity connected with a straight upright tube or air condenser (Fig. 13) and boiled for about twelve hours. The liquid on cooling solidifies. The contents while warm are therefore at once distilled with a condenser until excess of acetic acid has been expelled and the liquid which passes over begins to solidify (280°). The condenser is now removed, the

receiver changed and the distillation continued.* Care must be taken, by keeping the neck of the retort warm, that it does not become choked. The acetanilide which solidifies in the receiver has a yellow colour and smells of phenyl carbaniline. It may be recrystallised from boiling water and forms colourless



FIG. 13

tabular crystals, the purity of which may be ascertained by observing the melting point.

Melting-point determination.—For this purpose the following apparatus is used (Fig. 14). A small sample of the finely powdered substance, dried in a desiccator over sulphuric acid, is introduced into a fine capillary tube sealed at one end. The substance is shaken to

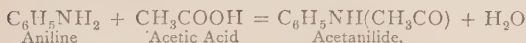
the bottom of the tube by gently tapping the sealed end. This portion of the tube attached to a thermometer by an india-rubber ring is immersed in conc. sulphuric acid contained in a small beaker, which it half fills. The beaker is gently heated over a small flame until the substance melts. The temperature is then noted.



FIG. 14.

The lower end of the thermometer bulb and the sealed end of the capillary tube must stand at the same level in the liquid (about $\frac{1}{2}$ to 1 cm. from the bottom of the vessel). The liquid is maintained at a uniform temperature whilst being heated by stirring gently with a glass rod the lower end of which is bent at right angles and then formed into a ring. By

slowly raising the temperature of the liquid the melting-point of the substance may be readily observed. The substance is allowed to cool and is reheated. In this way the freezing and melting-points (uncorrected)¹ may be repeatedly determined. The substance, if pure, melts completely and suddenly within one or two degrees; if impure the liquefaction is protracted and the melting-point usually too low. According to the temperature at which the substance melts, water, paraffin, or oil may replace the sulphuric acid in the bath used.



Properties.—Rhombic plates; m. p. 112°; b. p. 295°; on boiling with caustic potash or strong hydrochloric acid it is resolved into acetic acid and aniline.

¹ The following expression gives the correction required by the difference of temperature of the column of mercury outside the vessel, and is added to the observed temperature.

$$N(T-t) \cdot 000154$$

where T = apparent temperature in degrees

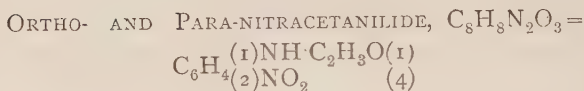
t = temperature of a second thermometer, the bulb of which is placed at half the length of N above the vessel

N = length of the mercury column in degrees from above the vessel to T

·000154 = apparent expansion of mercury in glass.

In the new apparatus of Roth (Ber. 19, 1970) this correction is obviated.

PREPARATION VI.



LITERATURE.—Körner (1876), *Chem. Soc. J.* **14**, 209; Witt (1875), *Ber.* **8**, 144; Grethen (1876), *Ber.* **9**, 775; Beilstein, Kurbatow (1879), *Ann. Ch. Pharm.* **197**, 83.

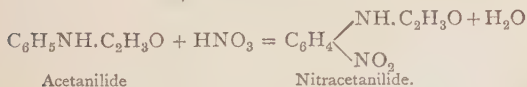
12 grms. acetanilide.

40 „ fuming nitric acid, sp. gr. 1.5.

Twelve grms. powdered acetanilide are added slowly and in small quantities to 40 grms. fuming nitric acid contained in a beaker cooled in water. The mixture must not be allowed to become warm, otherwise a violent reaction occurs and the nitro-compounds decompose. When the acetanilide has been added, the liquid has a deep red colour. It is now poured upon pounded ice or snow when the para- and a small quantity of ortho-compound separate out as a yellow curdy precipitate. This is rapidly filtered at the pump and washed once or twice with cold water. The filtrate, which has a red colour and contains the chief portion of the ortho-compound, is removed, the residue is again washed with water, well pressed, and dried at 100°. In order to dissolve out any ortho-nitracetanilide from the para-compound, the

dried substance is powdered and washed with cold chloroform until the washings are nearly colourless. The residue on the filter has a light yellow colour, and crystallises from alcohol in almost colourless needles.

The red-coloured filtrate containing the ortho-compound is extracted two or three times with chloroform, which dissolves it, forming a deep red layer at the bottom of the vessel. This is carefully separated. On distilling off the chloroform on the water-bath a red oil remains, which is poured, while still warm, into a beaker. On cooling it solidifies; more quickly if the bottom of the vessel is scratched with a glass rod. The crystals are spread upon a porous plate to drain and then dissolved in a small quantity of alcohol, in which the substance is readily soluble. To the hot alcoholic solution water is added until a cloudiness appears. On shaking, drops of red oil collect from which the liquid is filtered through a moistened filter. The clear filtrate on cooling deposits orange-coloured tabular crystals.



Properties.—*Para-nitracetanilide* colourless needles; m. p. 207°. On boiling a small quantity in a test-tube for a few minutes with an excess of concentrated

hydrochloric acid, until, on diluting, no precipitate is produced, the hydrochloride of para-nitraniline is formed, and on the addition of caustic potash solution the free base is precipitated in the form of acicular clusters; m. p. 147°.

Ortho-nitracetanilide orange-coloured plates; m. p. 78°. Treated with hydrochloric acid as above, it yields ortho-nitraniline, which crystallises in orange needles; m. p. 71·5°.

PREPARATION VII.

META-DINITROBENZENE, $C_6H_4O_4N_2 = C_6H_4 \begin{matrix} (1) NO_2 \\ (3) NO_2 \end{matrix}$

LITERATURE.--Deville (1841), Ann. Ch. Phys. (3) 3, 187; Hofmann, Muspratt (1846), Ann. Ch. Pharm. 57, 214; Beilstein, Kurbatow (1875), Ann. Ch. Pharm. 176, 44; Rinne, Zincke (1874), Ber. 7, 869; Körner (1876), Chem. Soc. J. 14, 207.

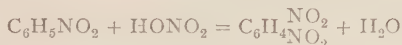
50 grms. nitrobenzene.

35 „ fuming nitric acid, sp. gr. 1·5.

35 „ conc. sulphuric acid.*

Fifty grms. nitrobenzene are added to a mixture of 35 grms. fuming nitric acid and 35 grms. conc. sulphuric acid contained in a flask of about half-litre capacity and well shaken after each fresh addition.* Heat is evolved, and the mass becomes somewhat deeper in colour. The

rate at which the nitrobenzene is run in is regulated by the temperature of the mixture, which should be maintained at about 70°—80°. When the nitrobenzene has been thus added, the contents of the flask are boiled for a short time on the sand bath, and are poured whilst warm into a large quantity of water. The meta-dinitrobenzene, mixed with small quantities of the ortho-and para-compounds, separates out as a yellow crystalline mass, which is filtered and washed with water on the filter-pump. It is then recrystallised from hot dilute alcohol. On cooling the alcoholic solution, meta-dinitrobenzene crystallises out in light yellow needles, and is free from its isomers, which remain dissolved in the mother liquor.

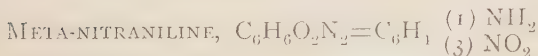


Nitrobenzene

Dinitrobenzene.

Properties. —Almost colourless long needles; m. p. 89·8°; b. p., 297°.

PREPARATION VIII.



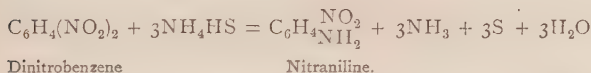
LITERATURE.—Muspratt, Hofmann (1846), Ann. Ch. Pharm. 57, 217; Arppe (1855), Ann. Ch. Pharm. 96, 114; Beilstein, Kurbatow (1875), Ann. Ch. Pharm. 176, 44; Hübner, Frerichs (1877), Ber. 10, 1716.

50 grms. m-dinitrobenzene.
150 „ alcohol (90 per cent.).
25 „ conc. ammonia.

Fifty grms. dinitrobenzene, 150 grms. dilute alcohol (90 per cent.), and 25 grms. conc. ammonia are mixed together in a half-litre flask, and into the dark red pasty mass sulphuretted hydrogen is passed, the mixture being well stirred meanwhile.* The dinitrobenzene slowly dissolves, and when the red liquid is saturated with the gas, crystalline flakes of ammonium thiosulphate begin to separate. When the solution is completely saturated, it is heated on the water-bath until any excess of sulphuretted hydrogen is expelled; at the same time sulphur separates out in quantity. After cooling, the liquid is again saturated with sulphuretted hydrogen as before, and heated on the water-bath, and the same process repeated until the contents of the flask have increased in weight about 30 grms. A sufficient quantity of water is now added to the liquid to precipitate the nitraniline and filtered.

In order to purify the crude product, it is repeatedly extracted with small quantities of dilute hydrochloric acid, the acid solution somewhat concentrated, whereby a small quantity of unchanged dinitrobenzene separates, and filtered. Conc. ammonia added to the filtrate precipitates the m-nitraniline, which may be purified by recrystallisation from boiling water. The filtrate from

the crude nitraniline is acidified with dilute hydrochloric acid, and evaporated to dryness on the water bath. The residue is extracted with dilute hydrochloric acid, and the filtered solution treated with conc. ammonia. In this way a further quantity of nitraniline may be obtained.



Properties.—Yellow needles; m. p. 114° ; b. p. 285° . Compare the melting point with that of ortho- and para-nitraniline, p. 28.

PREPARATION IX.



LITERATURE.—A. W. Hofmann (1850), Ann. Ch. Pharm. 74, 128.

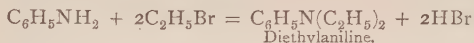
50 grms. aniline.

65 „ ethyl bromide.

A mixture of 50 grms. pure commercial aniline and 65 grms. ethyl bromide are heated on the water-bath in a flask connected with reflux condenser. After about three hours the contents of the flask have

solidified to a brownish crystalline mass consisting of the mixed hydrobromides of diethyl-, monoethyl-aniline and aniline. Water is added, which readily dissolves the hydrobromides, and then excess of caustic potash solution. The free bases separate out as a dark brown oily layer on the surface of the liquid. The aqueous portion is carefully separated and extracted with ether, the ether distilled, and the residue added to the other oil. The whole is mixed with an equal weight of acetic anhydride, which causes a considerable rise of temperature and converts the aniline and monoethylaniline into the corresponding acetyl compounds, whereas the diethyl compound is unacted upon. The mixture is distilled in a retort connected with a condenser and receiver. At first excess of acetic anhydride and some acetic acid pass over. The thermometer then rises rapidly and the portion distilling above 180° is collected in a separate vessel. At this point it is advisable to run the water out of the condenser to avoid cracking the tube or to replace the condenser simply by a straight wide tube. A portion of the distillate, on cooling, solidifies to a yellow crystalline mass. The oil is drained off by filtering with the pump through a platinum cone and the residue is washed with small quantities of cold and very dilute sulphuric acid. The filtrate contains the diethylaniline. The crystalline residue consists of the acetyl compounds

of aniline and monoethylaniline.¹ The filtrate is made alkaline with caustic potash solution extracted with ether and dehydrated over solid caustic potash. The ether is distilled off on the water-bath and the residual oil fractionated over the flame. The light yellow oil passing over at 210° — 215° is nearly pure diethylaniline.



Properties.—Colourless oil; b. p. 213.5° ; sp. gr. 0.936 at 18° .

PREPARATION X.

PARA-NITROSODIMETHYLANILINE,



LITERATURE.—Baeyer, Caro (1874), Ber. 7, 810 and 963; Schraube (1875), Ber. 8, 616; Wurster (1879), Ber. 12, 523.

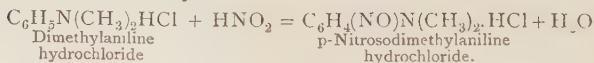
¹ The monoethylaniline may be isolated by boiling the mixed acetyl compounds with slight excess of 20 per cent. hydrochloric acid for two hours, adding excess of caustic potash solution and distilling with steam. The mixture of oil and water in the receiver is acidified with dilute sulphuric acid, and a small quantity of sodium nitrite solution slowly added to the cold solution. The aniline is converted into diazobenzene sulphate, which dissolves; the ethyl aniline into ethylphenylnitrosamine, which separates as an oil and may be extracted with ether. After distilling off the ether the nitrosamine is reduced with tin and hydrochloric acid, and is reconverted into monoethylaniline (Fischer).

50 grms. dimethylaniline.

125 ,, conc. hydrochloric acid diluted
with 250 grms. water.

30 ,, sodium nitrite.

To a solution of 50 grms. dimethylaniline in 125 grms. conc. hydrochloric acid diluted with 250 grms. water, rather more than the calculated quantity of sodium nitrite (30 grms.) dissolved in a small quantity of water is slowly added and the mixture well shaken and cooled in ice. The separation of the hydrochloride of nitrosodimethylaniline in the form of small yellow needles soon begins, and the liquid is gradually filled with a thick crystalline deposit. When after standing for some time no further increase in the quantity of crystals is observed, the mass is filtered at the pump and washed with alcohol containing hydrochloric acid. The salt may be purified by recrystallisation from hot water. It forms small yellow needles. In order to prepare the free base, the hydrochloride is mixed into a paste with water and excess of potassium carbonate or caustic soda solution added in the cold. The yellow colour of the salt changes to green and the free base, which is formed, is extracted with ether. On evaporating off the ether the base remains in the form of brilliant green foliated crystals.



Properties.—Large green foliated crystals; m. p. 85° ; somewhat volatile in steam. If a solution of the hydrochloride be saturated with H_2S and ferric chloride added to the liquid, a deep blue coloration is produced from the formation of methylene blue (Ber. **11**, 1705).

PREPARATION XI.

PARA-NITROSOPHENOL, $C_6H_5NO_2 = C_6H_4 \begin{smallmatrix} (1)O \\ (4)N.OH \end{smallmatrix}$.

(*Quinonoxime.*)

LITERATURE.—Baeyer, Caro (1874), Ber. 7, 809 and 963; Ter Meer (1875), Ber. 8, 622; Goldschmidt (1884), Ber. **17**, 214.

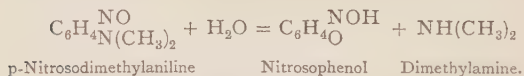
5 grms. nitrosodimethylaniline hydrochloride.

25 „ caustic soda solution (sp. gr. 1.25.)

225 „ water.

Twenty-five grms. caustic soda solution (sp. gr. 1.25) and 225 grms. water are heated to boiling in a round-bottomed flask connected with a condenser and receiver containing dilute hydrochloric acid. Five grms. nitrosodimethylaniline are gradually added to the soda solution by removing the cork for a moment. The free base, which separates out in oily drops, is allowed to dissolve before each fresh addition. The

boiling is continued until the dark green colour of the liquid changes to reddish yellow. The greater part of the dimethylamine, formed simultaneously with the nitrosophenol, passes over with the aqueous vapour and is absorbed in the receiver.¹ The liquid in the flask is thoroughly cooled, acidified with dilute sulphuric acid and extracted with ether. On distilling off the greater part of ether from the dark green solution, the nitrosophenol remains in brown foliated crystals, which are separated from the mother-liquor and dried.



Properties. Brown foliated crystals; soluble in hot water, alcohol, and ether; decomposes at 120°—130° with slight explosion leaving a residue of carbon. Dissolved in excess of phenol it gives on the addition of a few drops of conc. sulphuric acid a cherry-red solution, which changes to blue on the addition of water and caustic alkali (Liebermann's "nitroso" reaction).

¹ On evaporating down the hydrochloric acid solution on the water-bath colourless crystals of dimethylamine hydrochloride may be obtained.

PREPARATION XII.

POTASSIUM BENZENE SULPHONATE, $C_6H_5.SO_3K$.

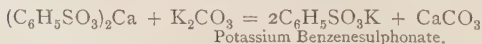
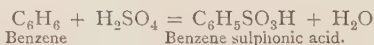
LITERATURE.—Mitscherlich (1834), Pogg. Ann. 31, 283 and 364; Michael, Adair (1877), Ber. 10, 585.

100 grms. benzene.

200 „ conc. sulphuric acid.

One hundred grms. pure commercial benzene and 200 grms. conc. sulphuric acid are mixed together in a round-bottomed flask of about $\frac{1}{2}$ litre capacity, provided with a reflux condenser, and the mixture kept at a gentle boil on the sand-bath for about twenty-four hours. The contents of the flask divide into two layers. The lower layer of acid assumes a dense black colour, and gradually increases in volume as the boiling continues, the upper layer of benzene diminishing in the same proportion until about four-fifths of the benzene has dissolved, when more prolonged heating produces no further change. After cooling, a portion of the unattacked benzene may be separated by means of a tap-funnel. The dark-coloured acid liquid is poured into a large volume (about 1 litre) of water, and any residual benzene is distilled off with steam. The liquid is then neutralised whilst hot with powdered chalk mixed into a paste with water or with milk of lime. The mass is filtered hot

through cloth from the precipitate of calcium sulphate, washed with hot water, and the faintly brown coloured filtrate carefully concentrated over the flame until a sample, withdrawn on the end of a glass rod, on cooling solidifies. From the solution the calcium salt of benzene sulphonic acid separates out on cooling, and forms an almost solid mass of small, white crystals, which, after being drained from the mother-liquor, are almost pure. In order to convert the calcium salt into the corresponding potassium salt, the former is dissolved in water, and, whilst hot, a concentrated solution of potassium carbonate carefully added, until the calcium is exactly precipitated as calcium carbonate. The aqueous solution of the potassium salt is filtered from the calcium carbonate through cloth and evaporated down first over the flame and finally on the water-bath until a sample crystallises on cooling. The potassium salt crystallises in the form of colourless crystalline plates, which after filtration and thoroughly drying on unglazed earthenware (a porous plate or tile) are sufficiently pure for further treatment.



Properties.—Colourless, pearly plates which slowly

effloresce in the air, and which melt above 300° with slight decomposition; very soluble in water, with difficulty in alcohol.

PREPARATION XIII.

PHENOL, $C_6H_6O = C_6H_5(OH)$.
(*Carbolic acid, Oxybenzene.*)

LITERATURE.—Runge (1834), Berz. Jahresh. 15, 417; Laurent (1842), Ann. Ch. Phys. (3) 3, 195; Gerhardt (1843), Ann. Ch. Pharm. 45, 25; Kekulé, Wurtz, Dusart (1867), Zeitsch. f. Ch. N. S. 3, 299, 300, 301; Degener (1878), Journ. prakt. Ch. (2), 17, 394.

20 grms. potassium benzene sulphonate
35 „ caustic potash.

Thirty-five grms. caustic potash, dissolved in the smallest quantity of water, are heated in a silver basin, preferably in the oil-bath (Fig. 15), and 20 grms. dry powdered potassium benzene sulphonate added, the mixture being well stirred.¹ The temperature of the oil-bath is maintained at 290° — 295° for one hour. In progress of fusion

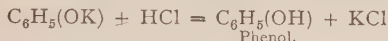
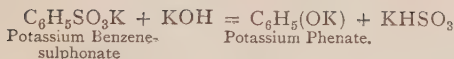
¹ Fusions with strong potash solution under pressure in many cases give better yields. For laboratory purposes a strong steel tube, capable of resisting a high pressure, and closed by a screw plug, is used and heated in a paraffin or oil bath. The fusion requires more time and is made at a lower temperature.

the mass is first thick and pasty ; but soon becomes semi-fluid, and remains in this condition, gradually changing in colour from yellow to brown until towards the end of the operation, when it regains somewhat its original consistency. On cooling, the melt is dissolved in water, and the alkaline reddish-brown liquid (sodium phenate and excess of alkali) acidified with conc.



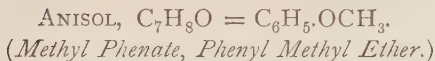
Fig. 15.

hydrochloric acid in the cold. Phenol separates out as a light yellow oil, which is extracted from the liquid with ether. The ethereal solution dehydrated over quicklime is distilled, first on the water-bath and then over the flame. The portion boiling at 175° — 185° is nearly pure phenol. It distils as a colourless liquid, and solidifies at once on introducing a small crystal of the same substance.



Properties.—Colourless needles possessing a smell resembling camphor; m. p. 40° — 41° ; b. p. 182° ; easily soluble in water, alcohol, and ether. It is coloured violet with ferric chloride, blue with bleaching powder solution; on the addition of bromine water a yellow flocculent precipitate of tribromophenol is formed. See also Liebermann's reaction (p. 36).

PREPARATION XIV.

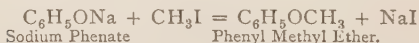


LITERATURE.—Cahours (1851), Ann. Ch. Pharm. 78, 226.

- 5 grms. sodium.
- 100 c.c. methyl alcohol (absolute).
- 20 grms. phenol.
- 40 „ methyl iodide.

Five grms. sodium cut into thin slices are dissolved in 100 c.c. pure methyl alcohol contained in a flask attached to a reflux condenser. To the solution, when cool, 20 grms. phenol are added and 40 grms. methyl iodide, and without removing the condenser

the whole heated on the water-bath for several hours until the solution has no longer an alkaline reaction. A portion of the methyl alcohol and methyl iodide are distilled off on the water-bath, and water added to the amber-coloured residue. After repeatedly washing with water to dissolve out the remainder of the methyl alcohol, a colourless oil separates out, which is extracted with ether, the ethereal solution dehydrated over fused calcium chloride, and distilled first on the water-bath until the ether has been driven off and then over the flame. Almost the whole of the residue distils at 150° — 155° .



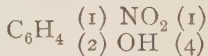
Sodium Phenate

Phenyl Methyl Ether.

Properties.—Colourless liquid possessing an agreeable smell; b. p. 152° ; sp. gr. '991 at 15° .

PREPARATION XV.

ORTHO- AND PARA-NITROPHENOL, $\text{C}_6\text{H}_5\text{NO}_3$



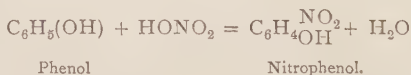
LITERATURE.—Hofmann (1857), Ann. Ch. Pharm. 103, 347; Fritzsche (1859), Ann. Ch. Pharm. 110, 150; Kekulé, Lehrbuch d. org. chem. 3, 40.

80 grms. phenol.
160 „ nitric acid, sp. gr. 1'34.
320 „ water.

To a mixture of 160 grms. nitric acid sp. gr. 1'34 and 320 grms. water, contained in a flask of about 1 litre capacity, 80 grms. melted phenol are gradually added in small quantities, and the contents of the flask well shaken. On the addition of the phenol, the liquid immediately changes to a deep brown or black colour, and a heavy dark brown oil separates out. When the whole of the phenol has been added, the mixture is allowed to stand for twelve hours. The oil has by that time collected at the bottom of the vessel, and may be freed from acid by repeatedly pouring in water, and carefully decanting. The contents of the flask consist of nearly equal quantities of para- and ortho-nitrophenol, mixed with resinous products. In order to separate the two isomers the product is distilled in a current of steam (see Fig. 12) until the distillate is almost colourless. The ortho-compound distils into the receiver in the form of a yellow oil, which solidifies at the ordinary temperature to needle-shaped crystals. By recrystallisation from hot dilute alcohol it is obtained well crystallised and pure.

The solid residue contains the para-compound mixed with black resinous substances, from which it

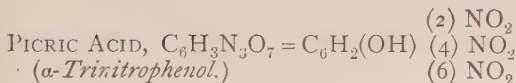
is separated by repeatedly extracting with boiling water. The united portions of the aqueous extract are boiled with animal charcoal and filtered. The light brown filtrate is made slightly alkaline with caustic soda solution, concentrated to a small bulk and allowed to crystallise. The brownish crystals are separated from the mother-liquor by draining and pressing at the filter-pump. These may be purified by recrystallisation from water. To obtain the free para-compound the concentrated aqueous solution of the sodium salt is acidified with dilute hydrochloric acid, and the nitrophenol, which separates out as a crystalline precipitate, is filtered and recrystallised from hot dilute alcohol.



Properties. — *Ortho-nitrophenol*, sulphur-yellow needles, possessing a peculiar aromatic smell; m. p. 45° ; b. p. 214° ; distillable with steam; soluble in alcohol, ether, and hot water; less soluble in cold water.

Para-nitrophenol, colourless needles; m. p. 114°; easily soluble in alcohol and hot water; with difficulty soluble in cold water.

PREPARATION XVI.



LITERATURE.—Woulfe (1771); Dumas (1833), Ann. Ch. Phys. 53, 178, and (1841) Ann. Ch. Phys. (3), 2, 228; Laurent (1841), Ann. Ch. Phys. (3) 3, 221; Schmidt, Glutz (1869), Ber. 2, 52.

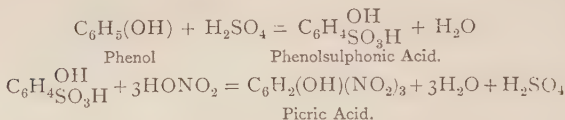
50 grms. phenol.

50 „ conc. sulphuric acid.

200 „ nitric acid, sp. gr. 1.4.

Fifty grms. commercial phenol and 50 grms. conc. sulphuric acid are heated together in a porcelain basin on the water-bath until a clear solution of phenolsulphonic acid is obtained. It is diluted with double the volume of water, and slowly added, in small quantities at a time, from a tap-funnel, to 200 grms. nitric acid, sp. gr. 1.4, contained in a flask of about $\frac{3}{4}$ litre capacity, which is well shaken during the process.* The liquid changes to a deep red colour, a considerable rise of temperature occurs, and red fumes are evolved. When the phenolsulphonic acid has been added, the flask is placed on the water-bath and heated until the red colour of the liquid changes to yellow. On cooling, picric acid separates out as a yellow crystalline mass. It is filtered (platinum cone

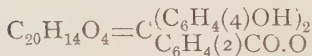
only) at the filter pump and washed free from the mother-liquor with water. It is then purified by recrystallisation from hot water, acidified with a few drops of sulphuric acid.



Properties.—Yellow prismatic crystals; m. p. 122.5° , subliming on gently heating; easily soluble in alcohol and ether; with difficulty in cold, more readily in hot water; the solution has a bitter taste. Heated gently with 2 parts of potassium cyanide in a dilute solution a brown crystalline precipitate of isopurpuric acid separates on cooling.

PREPARATION XVII.

PHENOLPHTHALEINE,



(*Di-p-oxydiphenylphthalid.*)

LITERATURE.—Baeyer (1876), Ber. 9, 1230 and (1880) Ann. Ch. Pharm. 202, 68.

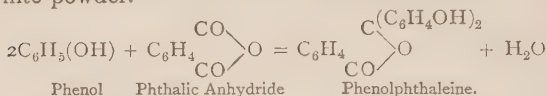
10 grms. phthalic anhydride.

20 „ phenol.

8 „ conc. sulphuric acid.

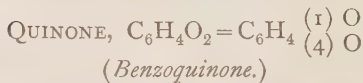
Ten grms. phthalic anhydride, 20 grms. phenol, and 8 grms. conc. sulphuric acid are heated together to 115° — 120° in the oil-bath for ten hours. The mass becomes semi-fluid and of a dark red colour. When the reaction is finished, the hot melt is poured into water, and boiled until the smell of phenol has disappeared, the water being renewed as it evaporates. The undissolved yellow granular precipitate is separated on cooling from the liquid by filtration, and washed with water. It is then dissolved in dilute caustic soda solution, filtered from the undissolved residue, and the filtrate acidified with acetic acid and a few drops of hydrochloric acid. The phthaleine separates out after standing for some hours as a light yellow sandy crystalline powder. It is filtered and purified by dissolving in absolute alcohol, with the addition of animal charcoal (1 part phenolphthaleine, 6 parts alcohol, and $\frac{1}{2}$ part charcoal), and boiling the solution on the water-bath with a condenser for $1\frac{1}{2}$ hours. The mass is filtered hot, the charcoal washed with 2 parts boiling alcohol, and the alcoholic filtrate evaporated down to two-thirds its bulk, on the water-bath. On the addition of 8 times the quantity of cold water to the cooled solution, the latter becomes turbid. The liquid is well stirred, and after standing a few seconds, filtered through cloth from the resinous oil, which separates out. On heating the filtrate for a time on the water-bath to expel excess of alcohol,

phenolphthaleine crystallises out in the form of a white powder.



Properties.—White, granular, crystalline powder; m. p. $250\text{--}253^\circ$; very slightly soluble in water, readily soluble in hot alcohol; soluble in caustic alkalis with a crimson colour.

PREPARATION XVIII.



LITERATURE.—Woskresensky (1838), Ann. Ch. Pharm. 27, 268; Wöhler (1843), Ann. Ch. Pharm. 45, 354 (1850), 51, 145 (1858), 65, 349; Graebe (1868), Ann. Ch. Pharm. 146, 1; Nietzki (1882), Ann. Ch. Pharm. 215, 125 and (1886) Ber. 19, 1467.

50 grms. aniline.
400 „ conc. sulphuric acid.
1500 „ water.
175 „ potassium dichromate.¹

Fifty grms. commercial aniline are dissolved in a mixture of 400 grms. conc. sulphuric acid and 1500

¹ An equivalent quantity of sodium dichromate dissolved in 2 to 3 times its weight of water may be used (Nietzki).

grms. water, contained in a round-bottomed flask of about 4 litres capacity, and to the well-cooled solution of aniline sulphate 175 grms. finely powdered potassium dichromate are slowly added in small portions at a time. It is necessary for the success of the operation that the flask be thoroughly well shaken after each fresh addition of dichromate, and that the temperature of the mixture does not rise above that of the outside atmosphere. Aniline black separates out at first, the greenish colour of which changes towards the end of the operation to a violet black. When all the dichromate has been added, the mixture is heated for a time to 35° on the water-bath, and, on cooling, extracted repeatedly with small quantities of ether. On distilling off the solvent, quinone remains in the form of yellow needle-shaped crystals, which are usually discoloured by the presence of quinhydrone. The substance is, however, sufficiently pure for most purposes, and is well adapted for the preparation of hydroquinone. By recrystallisation from ligroin the quinone is obtained well crystallised and free from quinhydrone.

The reaction consists in oxidation and elimination of the amido-group and simultaneous replacement of two hydrogen atoms in the benzene nucleus by oxygen, and cannot well be expressed in the form of equation.

Properties.—Golden yellow needle-shaped crystals; m. p. 116° ; with difficulty soluble in water, readily soluble in alcohol and ether; it sublimes on heating,

and volatilises at ordinary temperatures. Its vapour has a penetrating smell, and attacks the eyes.

PREPARATION XIX.

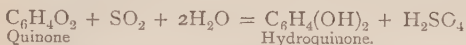
HYDROQUINONE, $C_6H_6O_2 = C_6H_4 \begin{matrix} (1) \text{ OH} \\ (4) \text{ OH} \end{matrix}$
(Paradioxybenzene, Paraoxyphenol, Quinol.)

LITERATURE. — Pelletier, Caventou; Wöhler (1844), Ann. Ch. Pharm. 51, 150; Nietzki (1882), Ann. Ch. Pharm. 215, 125.

50	grms.	aniline.
400	„	conc. sulphuric acid.
1500	„	water.
125	„	potassium dichromate.

The first part of the operation in the preparation of hydroquinone is identical with that of quinone. Instead, however, of extracting with ether, the brown solution resulting from the oxidation of aniline sulphate and potassium dichromate is directly treated with either a concentrated solution of sodium bisulphite or with sulphur dioxide, the latter being passed into the liquid, until, after standing for a time, it retains the smell of the gas. The product is now repeatedly extracted with ether, the ether distilled off, and the dark-coloured residue recrystallised from water, with

the addition of sulphurous acid and animal charcoal, until it becomes colourless and gives the correct melting-point.



Properties.—Colourless prisms; m. p. 169° ; sublimes at a gentle heat; easily soluble in alcohol, ether, and hot water, less soluble in cold water.

PREPARATION XX.

BENZYL CHLORIDE, $\text{C}_7\text{H}_7\text{Cl} = \text{C}_6\text{H}_5\text{CH}_2\text{Cl}$.

LITERATURE.—Cannizzaro (1853), Ann. Ch. Pharm. 88, 129; and (1855) 96, 246; Beilstein, Geitner (1866), Ann. Ch. Pharm. 139, 331.

100 grms. toluene.

One hundred grms. toluene (b. p. $110-111^\circ$) are gently boiled in a tared retort of about 300 c.c. capacity to which a reflux condenser is connected, and into the boiling liquid dry chlorine is conducted¹ in a somewhat rapid stream, preferably in direct sunlight (Fig. 16).^{*} The process is continued until the retort has gained 37 grms. in weight. The liquid becomes light yellow

¹ The chlorine is evolved by gently warming a mixture of manganese dioxide in lumps and conc. hydrochloric acid. The gas is dried through strong sulphuric acid.

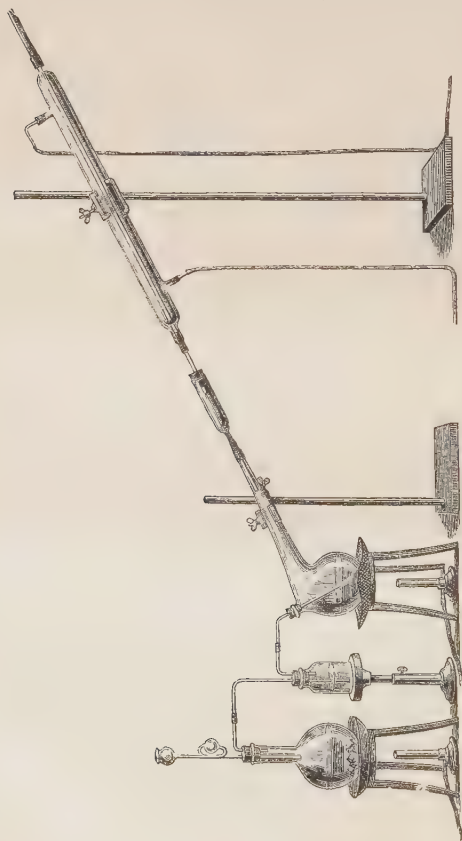
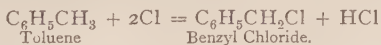


FIG. 16

in colour and hydrochloric acid fumes are evolved at the upper end of the condenser. When the reaction is complete, the contents of the retort are distilled.* At first unchanged toluene distils; the fraction boiling at $165-185^{\circ}$ contains nearly the whole of the benzyl chloride, and forms the greater part of the product. The liquid which passes over above 185° is a mixture of higher chlorinated compounds, and consists chiefly of benzylene and benzenyl-chlorides. The portion containing the benzyl chloride is repeatedly fractionated until a liquid is obtained boiling at $176-180^{\circ}$, which is nearly pure benzyl chloride.



Properties.—Colourless liquid with a penetrating smell; b. p. 179° ; sp. gr. 1.107 at 14° .

PREPARATION XXI.

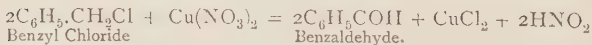
BENZALDEHYDE, $\text{C}_7\text{H}_6\text{O} = \text{C}_6\text{H}_5\text{COH}$.

(*Bitter Almond Oil*.)

LITERATURE.—Liebig, Wöhler (1837), Ann. Ch. Pharm. 22, 1; Lauth, Grimaux (1867), Ann. Ch. Pharm. 143, 186.

50 grms. benzyl chloride.
40 „ copper nitrate.
500 „ water.

Fifty grms. benzyl chloride and 40 grms. copper nitrate, dissolved in 500 grms. water are heated to boiling in a round-bottomed flask with reflux condenser on the sand-bath for 8 to 10 hours. A slow current of carbonic acid is at the same time passed through the liquid to prevent oxidation of the benzaldehyde by absorption of oxygen from the air. During the process nitrous fumes are slowly evolved. When the reaction is complete the contents of the flask are extracted with ether, and the yellowish oil remaining, after distilling off the ether, is well shaken with a saturated solution of sodium bisulphite,¹ and allowed to stand for a time. The colourless crystalline mass which separates out is filtered, washed with alcohol and ether and then drained on the filter. The aldehyde is regained from the sodium bisulphite compound by heating with excess of sodium carbonate solution or dilute sulphuric acid, and distilled over with steam. The distillate is extracted with ether, and the residue left after distilling off the ether is dehydrated over calcium chloride. The benzaldehyde is redistilled and is then pure.



¹ The solution is prepared by passing sulphur dioxide into powdered sodium carbonate covered with a layer of water. The carbonate dissolves with effervescence, forming a heavy apple-green liquid smelling strongly of sulphur dioxide.

Properties.—Colourless liquid, with a pleasant aromatic smell; b. p. 179° ; sp. gr. 1.0504 at 15° ; it quickly oxidises in the air, forming benzoic acid; in contact with strong aqueous ammonia, crystals of hydrobenzamide are deposited. Add to a drop of the aldehyde in half a test-tube full of water a solution of 1 pt. phenylhydrazine hydrochloride, $1\frac{1}{2}$ pts. sodium acetate, and 8—10 pts. water. On shaking a thick white flocculent precipitate is formed (Fischer's reaction for aldehydes, Ber. 17, 574).

PREPARATION XXII.

BENZYL ALCOHOL, $C_7H_8O = C_6H_5CH_2OH$.

LITERATURE.—Cannizzaro (1853), Ann. Ch. Pharm. 83, 129; and (1855) Ann. Ch. Pharm. 96, 216; R. Meyer (1881), Ber. 14, 2394.

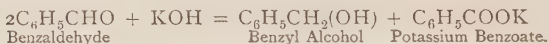
40 grms. benzaldehyde.

36 „ caustic potash.

24 „ water.

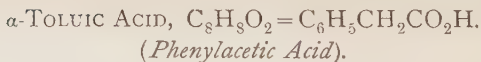
Forty grms. benzaldehyde, and a solution of 36 grms. caustic potash in 24 grms. water are shaken together in a well-stoppered bottle until a permanent emulsion is formed. The contents of the bottle after a short time become hot, and on standing for about twenty hours, solidify to a mass of white crystals of potassium

benzoate. Water is added (about 200 c.c.) sufficient to dissolve the crystals, the benzyl alcohol also going into solution. The clear solution is extracted repeatedly with ether, the ether expelled and the colourless residual oil directly distilled without being previously dehydrated. As soon as the last traces of ether have passed over, the thermometer rises rapidly to the boiling point of benzyl alcohol and the whole distils within 2 to 3 degrees.



Properties.—Colourless liquid with a faint aromatic smell; b. p. 206.5° ; sp. gr. 1.0507 at 15.4° .

PREPARATION XXIII.



LITERATURE.—Cannizzaro (1855), Ann. Ch. Pharm. 96, 247; T. Maxwell (1879), Ber. 12, 1764; Spiegel (1881), Ber. 14, 239; Mann (1881), Ber. 14, 1645; Staedel (1886), Ber. 19, 1951.

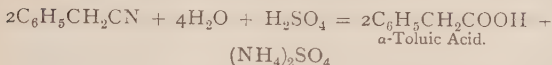
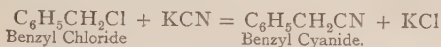
60 grms potassium cyanide 99 per cent.
55 „ water.
100 „ benzyl chloride.
100 „ alcohol.

In a $\frac{3}{4}$ litre round-bottomed flask, to which a reflux condenser is attached, 60 grms. potassium cyanide, 99 per cent. are dissolved in 55 grms. water. A solution of 100 grms. benzylchloride in 100 grms. alcohol are poured slowly into the hot solution of potassium cyanide through the top of the condenser. The whole is then gently boiled for 3-4 hours on the sand-bath.* The liquid separates into two layers, and as the boiling continues the upper layer gradually assumes a brown colour, and at the same time crystals of potassium chloride separate out at the bottom of the vessel. At the end of this time the flask is allowed to cool, and the upper dark brown liquid, consisting of an alcoholic solution of benzyl cyanide, decanted from the crystalline deposit of potassium chloride and distilled over wire gauze.* The thermometer stands for some time at about 80° until the alcohol is all off, a small quantity of water and benzyl cyanide distil at 100° ; the temperature then rises quickly to 210° , and the fraction boiling at $210-235^{\circ}$ consisting chiefly of benzyl cyanide is collected apart. It has a slightly brownish yellow colour. By the action of sulphuric acid it is converted into phenylacetic acid.

50 grms. benzylcyanide.	
150 „ sulphuric acid	{ 3 vol. conc. sulphuric acid.
	{ 2 „ water.

50 grms. benzyl cyanide and 150 grms. of a mixture of 3 vol. conc. sulphuric acid and 2 vol. water are introduced into a $\frac{1}{2}$ litre flask, which is connected by a glass tube bent twice at right angles with a Woulff bottle. The end of this tube passes just beneath the cork in the one tubulus of the bottle which contains water. Through the second tubulus a vertical glass tube about $1\frac{1}{2}$ foot long is fitted and dips just below the surface of the water. About the middle of the tube a large bulb is blown. The flask containing the mixture (which divides into two layers) is heated over the naked flame gently at first, and then the temperature gradually raised until small bubbles of gas are observed to rise from the surface of the lower layer of acid. The flame is now removed, and in a few minutes a strong reaction begins; the liquid boils and a small quantity of benzyl cyanide distils over into the Woulff bottle. At the same time the water is forced up the vertical tube into the bulb, which serves as a valve. The reaction is over in about half a minute; the flask is again heated for 2-3 minutes and then allowed to cool. On standing the liquid solidifies to a laminated crystalline mass. It is purified by washing with cold water. The crystals are dissolved in water, neutralised with sodium carbonate solution, the hot solution filtered and acidified with dilute sulphuric acid. On standing, colourless plates of the free acid separate which are filtered and washed. These may be

further purified by a second crystallisation from hot water.

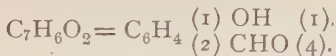


Properties.—Colourless, thin laminated crystals; m. p. 76.5° ; b. p. 262° .

PREPARATION XXIV.

SALICYLALDEHYDE (Ortho-oxybenzaldehyde).—

PARA-OXYBENZALDEHYDE.



LITERATURE.—Reimer, Tiemann (1876), Ber. 9, 824; Tiemann, Herzfeld (1877), Ber. 10, 62 and 213

50 grms. phenol.

100 „ caustic soda.

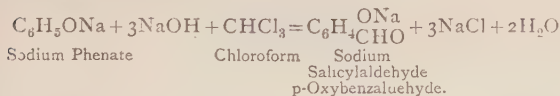
160 „ water.

75 „ chloroform.

Fifty grms. phenol are dissolved in a solution of caustic soda containing 100 grms. caustic soda in 160 grms. water, and the whole introduced into a 1 litre round-bottomed flask provided with a reflux condenser, and then heated to 50 — 60° . 75 grms. chloroform

are slowly added through the condenser, and after each addition the flask is well shaken. A gentle reaction sets in and the temperature rises. At the same time the surface of the brownish yellow solution takes a violet red tint, which rapidly fades, the liquid finally assuming a deep red colour. When the whole of the chloroform has been added the contents of the flask are boiled for $\frac{1}{2}$ hour without removing the condenser, and a yellow semi-solid mass separates out of the solution. The unattacked chloroform is now distilled off on the water-bath, the liquid diluted with water and strongly acidified with dilute hydrochloric or sulphuric acid. A thick dark red oil separates out on the surface, which is subjected to distillation in steam. An oil having a faintly yellow colour distils over with the water and settles to the bottom of the receiver. When drops of oil cease to condense, the distillation is stopped. The distillate, which contains salicylaldehyde and phenol, is extracted with ether and the ethereal solution well shaken with a saturated solution of sodium bisulphite. The bisulphite compound of salicylaldehyde separates out in colourless needles, which are filtered, washed free from traces of phenol with alcohol and then decomposed by heating with dilute sulphuric acid. The aldehyde which separates out is taken up with ether and the ether driven off. It is dehydrated over calcium chloride and finally distilled. In the distilling flask from which the salicyl

aldehyde has in the first instance been removed with steam, there remains a brownish liquid and a dark red substance, which sinks to the bottom of the vessel and forms a brittle resin on cooling. The aqueous portion is filtered hot through a moistened filter, which retains the resin, and the filtrate containing p-oxybenzaldehyde formed simultaneously in the above reaction is extracted when cold with ether. On distilling off the solvent, p-oxybenzaldehyde remains in the form of a yellow mass of stellar-shaped needles, which may be purified by recrystallisation from small quantities of hot water.



Properties—*Salicylaldehyde*. Colourless pleasant-smelling oil, b. p. 196.5° ; sp. gr. 1.1731 at 13.5° ; solidifies at -20° in large crystals. Volatile in steam; soluble in water; miscible in all proportions with alcohol and ether. The aqueous solution is coloured deep violet with ferric chloride.

Paraoxybenzaldehyde. Colourless needles; m. p. 115—116°; with difficulty soluble in cold water, more readily soluble in hot water, alcohol, and ether. Not volatile in steam. The bisulphite of sodium compound is easily soluble in water. Ferric chloride colours the aqueous solution violet

PREPARATION XXV.

ACETOPHENONE, $C_6H_5O = C_6H_5 \cdot CO \cdot CH_3$.
(*Phenylmethylketone*.)

LITERATURE.—Friedel (1858), *Compt. rend.* 47, 552.

100 grms. calcium benzoate.¹
50 „ calcium acetate.

One hundred grms. finely powdered and anhydrous calcium benzoate are thoroughly mixed with 50 grms. dry powdered calcium acetate. An iron tube is half filled with the mixture. The tube is placed in a furnace, connected with condensing tube and receiver (Fig. 17), and rapidly heated from the open end towards the closed end until no more liquid condenses. A brown oil distils over. The distillate, which contains a little water, is dehydrated over calcium chloride and fractionated. A small quantity of a colourless low-boiling liquid containing benzene first distils, the temperature then rises quickly to

¹ *Preparation of Calcium Benzoate and Acetate*.—A hot solution of 100 grms. benzoic acid in about 1 litre water is made alkaline with milk of lime, filtered from excess of lime and concentrated. The hydrated lime salt crystallises on cooling in long needles, which are separated from mother-liquor, dried at 100°, finely powdered, and then freed from water by heating the salt on a flat iron tray with constant stirring until moisture ceases to condense on the cold surface of a watch-glass held above the substance. Calcium acetate is prepared similarly.

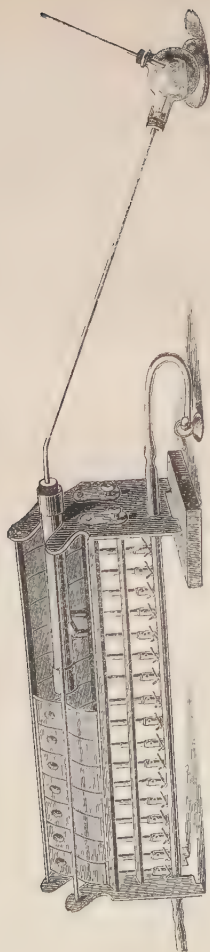
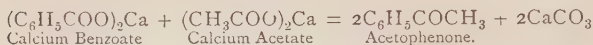


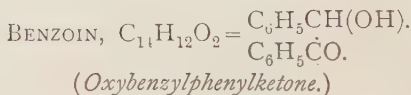
FIG. 17

195°, and the product boiling at 195—205° and possessing a faint yellow colour is separately collected. This portion is fractionated between 198° and 202° and is nearly pure acetophenone. It crystallises on cooling to 0°.



Properties.—Colourless tabular crystals; b. p. 202°; m. p. 20·5°.

PREPARATION XXVI.

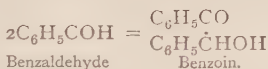


LITERATURE.—Liebig, Wöhler (1832), Ann. Ch. Pharm. 3. 276; Zinin (1840), Ann. Ch. Pharm. 34, 186; Zincke (1879), Ann. Ch. Pharm. 198, 151.

50 grms. benzaldehyde.
5 „ potassium cyanide.
200 „ alcohol 50 per cent.

Fifty grms. benzaldehyde are added to a solution of 5 grms commercial potassium cyanide in 200 grms. alcohol 50 per cent., and the mixture is heated on the

water-bath with a condenser for about half an hour. On cooling the liquid, benzoin separates out as a mass of small colourless crystals, which are filtered off from the mother liquor. From the latter a further quantity of benzoin may be obtained by adding 2—3 grms. potassium cyanide and again heating for a short time on the water-bath. The second crop of crystals is added to the first and the whole recrystallised from hot alcohol.



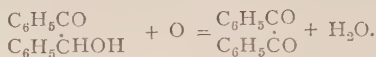
Properties.—Colourless prisms; m. p. 137° ; with difficulty soluble in water; easily soluble in alcohol and ether. The solution in dilute alcohol reduces Fehling's solution on warming. On oxidation with nitric acid it yields benzil, $\text{C}_6\text{H}_5\text{CO}\cdot\text{CO}\cdot\text{C}_6\text{H}_5$.

Benzil.—15 grms. benzoin.

35 „ conc. nitric acid sp. gr. 1.4.

Fifteen grms. benzoin are heated on the water-bath with 35 grms. conc. nitric acid in a flask connected with an air condenser, the flask being well shaken. Nitrous fumes are evolved and the crystals of benzoin are converted into a yellow oil, which after two hours heating is free from unchanged benzoin. After oxidation the contents of the flask are poured into water and the yellow crystalline deposit separated by filtra-

tion, washed with water and recrystallised from alcohol or ether.



Properties.—Yellow prisms; m. p. 95° ; insoluble in water, easily soluble in hot alcohol and ether; dissolves in cold alcoholic potash solution with a violet colour.

PREPARATION XXVII.

BENZILIC ACID, $\text{C}_{14}\text{H}_{12}\text{O}_3 = (\text{C}_6\text{H}_5)_2\text{C}(\text{OH})\cdot\text{CO}_2\text{H}$.
(*Diphenylglycollic Acid.*)

LITERATURE.—Liebig (1838), Ann. Ch. Pharm. **25**, 25; Zinin (1839), Ann. Ch. Pharm. **31**, 329; E. Fischer (1885), Ber. **14**, 326.

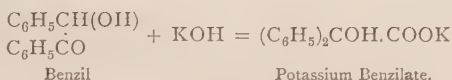
10 grms. benzil.

50 „ caustic potash.

Fifty grms. caustic potash are melted with a small quantity of water in a silver crucible on the oil-bath. The temperature of the mass is brought to 150° and 10 grms. finely powdered dry benzil added. The benzil melts and the contents of the crucible shortly change to a solid mass of potassium benzilate. The cooled melt is dissolved in water and the alkaline

solution acidified with hydrochloric acid, which precipitates the benzoic acid.

The crystalline mass, which contains small quantities of benzoic acid, is separated from the mother-liquor and washed with cold water. It is then transferred to a porcelain basin, dissolved in hot water and the solution boiled until the smell of benzoic acid has entirely disappeared. On cooling, benzoic acid crystallises out and is purified by a second crystallisation from hot water.



Properties.—Colourless needles; m. p. 150° ; scarcely soluble in cold, readily in hot water and alcohol; dissolves in conc. sulphuric acid with an intense red colour.

PREPARATION XXVIII.

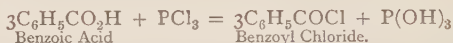
BENZOYL CHLORIDE, $\text{C}_7\text{H}_5\text{OCl} = \text{C}_6\text{H}_5\text{COCl}$.

LITERATURE.—Wöhler (1832) Ann. Ch. Pharm. 3, 262; Cahours (1846), Ann. Ch. Pharm. 60, 255, and (1849), 70, 40.

50 grms. benzoic acid.
30 „ phosphorus trichloride.¹

¹ The pentachloride may also be used, in which case three times the quantity must be taken. The reaction is started by

Fifty grms. dry benzoic acid are introduced into a flask connected with a spiral condenser and 30 grms. phosphorus trichloride are added.* When the reaction which proceeds at the ordinary temperature is finished, the contents of the flask are heated on the oil-bath to 120° until the evolution of hydrochloric acid ceases. The benzoyl chloride is obtained from the liquid product by distillation. Unchanged phosphorus trichloride first passes over, the thermometer then rises to 195° and benzoyl chloride begins to distil. The latter after a second distillation is chemically pure.



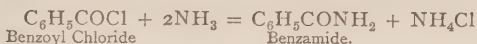
Properties.—Colourless liquid with a penetrating odour; b. p. 198.5° ; sp. gr. 1.2142 at 19° ; decomposes with water forming hydrochloric acid and benzoic acid. With ammonia it yields benzamide ($\text{C}_6\text{H}_5\text{CONH}_2$).

Benzamide.—5 grms. benzoyl chloride.

10 „ ammonium carbonate.

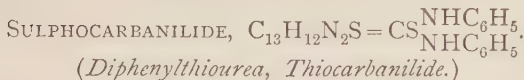
Five grms. benzoyl chloride are slowly added to 10 grms. finely powdered commercial ammonium carbonate and thoroughly mixed in a mortar.* The reaction proceeds quietly. If the smell of benzoyl warming, and is complete when the benzoic acid has dissolved. Hydrochloric acid is evolved, and phosphorus oxychloride formed, the latter being removed by fractional distillation.

chloride does not entirely disappear, the mass is heated for about twenty minutes on the water-bath or a few drops of strong aqueous ammonia added. It is allowed to cool, extracted with cold water and filtered. The benzamide remains on the filter in the form of a white crystalline powder, and may be recrystallised from a small quantity of boiling water.



Properties.—Colourless plates; m. p. 128° ; b. p. 290° ; scarcely soluble in cold, more readily in boiling water; soluble in alcohol and ether.

PREPARATION XXIX.



LITERATURE.—Hofmann (1849), Ann. Ch. Pharm. 70, 142; Weith (1873), Ber. 6, 967; Losanitsch (1886), Ber. 19, 1821.

100 grms. aniline

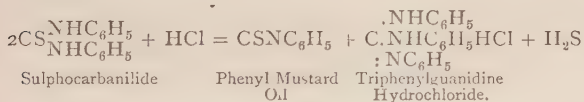
50 „ carbon bisulphide

50 „ absolute alcohol.

A solution of 100 grms. pure commercial aniline, 50 grms. carbon bisulphide,¹ and 50 grms. absolute

¹ Carbon bisulphide being very volatile and exceedingly inflammable, great care must be taken when using this substance in the neighbourhood of a flame.

a flask connected with a reflux condenser for about half an hour. The diphenylthiourea is decomposed into triphenylguanidine, which remains as the hydrochloride salt in solution, and phenyl mustard oil, which separates out as a brown oil. On distilling the product with steam, phenyl mustard oil collects at the bottom of the receiver as an almost colourless oil, and is separated from the aqueous layer either by extracting with ether or by means of a tap-funnel. It is dehydrated over calcium chloride, and finally distilled over a small quantity of phosphorus pentoxide.



Properties.—Colourless oil; b. p. 220° ; sp. gr. 1.135 at 15° ; insoluble in water; soluble in alcohol; on heating with alcoholic ammonia (1 vol. phenyl mustard oil, 1 vol. alcohol, 3 vols. conc. ammonia) it is converted into sulphocarbanilamide, $\text{NH}_2\text{CS.NH}(\text{C}_6\text{H}_5)$, which, on cooling, crystallises out in colourless needles.

Triphenylguanidine.—In order to separate the triphenylguanidine remaining in the flask as hydrochloride after distilling off the phenyl mustard oil, the hot solution is filtered and somewhat concentrated. The colourless salt, which crystallises out on cooling, is washed with a small quantity of water, and boiled

with caustic soda solution with reflux condenser. The base is set free and separates out as a white powder. It is washed with water and purified by re-crystallising from alcohol, with the addition, if necessary, of animal charcoal. Colourless needles; m. p. 143° .

PREPARATION XXXI.

BENZONITRIL, $C_7H_5N = C_6H_5CN$.

LITERATURE.—Letts (1872), Ber. 5, 669; Sandmeyer (1884), Ber. 17, 2653; Krüss (1884), Ber. 17, 1767.

50 grms. benzoic acid

19 „ potassium sulphocyanide.

A mixture of 50 grms. dry benzoic acid and 19 grms. dry potassium sulphocyanide are heated in a retort of half litre capacity connected with an air condenser on the oil-bath or over the bare flame.* The mixture melts and forms two layers, of which the lower one is benzoic acid. At 190° the reaction commences, sulphuretted hydrogen and carbonic acid being evolved; at a higher temperature the liquid begins to boil and soon swells up and solidifies to a white mass. The contents of the retort are now directly distilled from the same vessel, and the distillation continued until no more liquid passes over, care being taken not to char the residue in the retort

which consists of potassium benzoate. Dilute ammonia is added to the semi-solid distillate containing benzonitril and benzoic acid, and the liquid extracted with ether. On evaporating off the ether benzonitril remains as an oily liquid and is purified by distillation.



Properties.—Colourless liquid smelling slightly of bitter almonds; b. p. 191° ; sp. gr. 1.023 at 0° .

PREPARATION XXXII.



LITERATURE.—Griess (1866), Ann. Ch. Pharm. 137, 39; Sandmeyer (1884), Ber. 17, 2653; Klason (1887), Ber. 20, 349.

15 grms. aniline.

16 ,, nitric acid sp. gr. 1.4.

Fifteen grms. pure commercial aniline are dissolved in the cold in the calculated quantity of nitric acid sp. gr. 1.4 (16 grms.) previously diluted with 20 c.c. water, and the crystalline mass filtered and washed with small quantities of cold water until free from mother-liquor. The crystals of aniline nitrate are rubbed with a little water into a stiff paste, and a fairly rapid current of

nitrogen trioxide¹ passed into the mixture, which is kept well cooled with ice* (Fig. 18). Special care must be taken that the temperature of the liquid does not exceed 10° during the operation. After fifteen to twenty minutes the crystals have dissolved and the reaction is then complete. Alcohol (about three times the volume of alcohol 99 per cent.) is added to the resulting dark-coloured fluid, whereby a crystalline magma of fine needles separates, the quantity of which

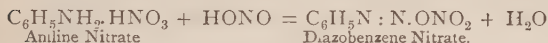


FIG. 18.

further increases on the addition of ether. The crystalline precipitate is filtered (with funnel and platinum cone only) and washed free from the mother liquor with a mixture of alcohol and ether. The crystals must be kept moist, as in the dry state a

¹ Nitrogen trioxide is prepared from small pieces of arsenic trioxide, which are placed in a flask and covered with a layer of conc. nitric acid. On gently warming, nitrogen trioxide is evolved, and is freed from any nitric acid which may be carried over by passing it through an empty vessel (Fig. 18).

slight touch may produce a violent explosion. The salt, when colourless, is therefore immediately subjected to further treatment, as described below.



Properties.—Colourless capillary needles; easily soluble in water; with difficulty soluble in alcohol; insoluble in ether.

Iodobenzene.—Three-quarters of the diazobenzene nitrate prepared as above is dissolved in water, and either aqueous hydriodic acid or an aqueous solution of potassium iodide slowly added. The diazo-compound is rapidly decomposed with an abundant evolution of nitrogen and the iodobenzene separates from the aqueous solution as a heavy oil. When on further addition of potassium iodide no more oil forms, the contents of the vessel are distilled with steam, and the iodobenzene, which collects in the receiver, purified as in the case of bromobenzene. (Colourless liquid, which soon turns red on standing; b. p. 188° ; sp. gr. 1.69). A portion of the remaining diazo-compound is warmed in a test-tube with water. When the evolution of nitrogen has ceased, the smell of phenol will be apparent. On treating another portion in the same way with alcohol, benzene is formed. If to a fourth portion, dissolved in water, a little bromine dissolved in potassium bromide be

added a brown oil separates out, which, on pouring off the water and adding ether, solidifies. This is diazobenzene perbromide. On boiling with alcohol bromobenzene is formed. Not more than half a gm. of the substance is dried on filter-paper. On being struck or heated it detonates.

PREPARATION XXXIII.

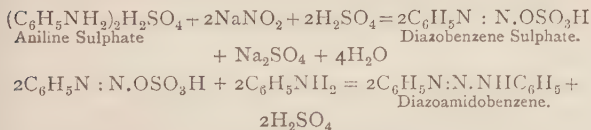


LITERATURE.—Griess (1862) *Ann. Ch. Pharm.* **121**, 258 and (1866) *Ann. Ch. Pharm.* **137**, 53; Martius (1866), *Zeitschr. f. Ch. N. S.* **2**, 381; Staedel, Bauer (1886), *Ber.* **19**, 1952.

20 grms. aniline
 6 ,, conc. sulphuric acid
 600 ,, water
 7.4 ,, sodium nitrite.

Six grms. conc. sulphuric acid diluted with 600 grms. water are added to 20 grms. aniline contained in a beaker of about $1\frac{1}{2}$ litre capacity. About half the aniline dissolves as sulphate. The liquid is heated to 27° and maintained at a temperature of 27° to 30° for fifteen minutes, 7.4 grms. commercial sodium nitrite dissolved in a small quantity of water being meanwhile slowly added, and the whole well stirred.

If the temperature falls below 25° or rises above 35° an impure product is obtained. As soon as the sodium nitrite is added the liquid turns yellow, and rapidly becomes turbid from the formation of diazoamidobenzene, which separates out as a yellowish brown crystalline precipitate. The solution is now allowed to stand at the ordinary temperature for half an hour, when almost the whole of the diazoamidobenzene crystallises out. It is filtered, washed with cold water, pressed well on the filter, and dried between filter paper. It forms a sandy powder, and may be purified by re-crystallisation from benzene or alcohol. For the preparation of amidoazobenzene the dry powder is sufficiently pure.



N.B.—The sulphuric acid set free in the second phase of the reaction acts upon the sodium nitrite, so that one molecule only is required.

Properties.—Golden yellow plates (from alcohol); m. p. 91° ; insoluble in water; difficultly soluble in cold alcohol; more readily soluble in hot alcohol, ether, and benzene; it explodes when heated above its melting point.

PREPARATION XXXIV.

AMIDOAZOBENZENE, $C_{12}H_{11}N_3 = C_6H_5N : NC_6H_4NH_2$.
(*Aniline yellow*.)

LITERATURE.—Mène (1861), Jahresb. 496; Kekulé (1866), Zeitsch. f. Ch. N. F. 2, 689; Staedel, Bauer (1886), Ber. 19, 1953.

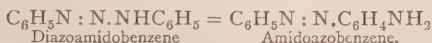
20 grms. diazoamidobenzene.

50 „ aniline.

2 „ aniline hydrochloride.

Twenty grms. diazoamidobenzene, 50 grms. aniline and 2 grms. powdered aniline hydrochloride are mixed together at the ordinary temperature, and the mixture then heated to 40° — 50° , and maintained at this temperature for an hour. The mixture forms a clear deep red solution. After standing for twenty-four hours at the ordinary temperature, the diazoamidobenzene is converted into amidoazobenzene. An excess of conc. hydrochloric acid is added, care being taken that no great evolution of heat occurs. (If unchanged diazoamidobenzene is present, there is evolution of nitrogen with effervescence.) On cooling, the amidoazobenzene separates out together with aniline hydrochloride, as a thick crystalline mass. This is filtered and washed with dilute hydrochloric acid and water, when small violet crystals of amidoazobenzene hydrochloride remain on the filter. The salt is dissolved in boiling

water, with the addition of a small quantity of dilute hydrochloric acid, and crystallises on cooling in steel-blue needles. In order to prepare the free base, the hydrochloride is dissolved in rather more than double the weight of alcohol, and conc. ammonia slowly added, until the colour of the solution changes to light brown. On the gradual addition of water the base crystallises out in brown needles, which may be purified by a second crystallisation from dilute alcohol with the addition of animal charcoal.



Properties.—Yellow rhombic prisms; m. p. 123°; b. p. above 300°. Scarcely soluble in hot water, more readily in hot alcohol.

PREPARATION XXXV.

PHENYLHYDRAZINE, $\text{C}_6\text{H}_8\text{N}_2 = \text{C}_6\text{H}_5\text{NH}.\text{NH}_2$.

LITERATURE.—E. Fischer (1878), Ann. Ch. Pharm. 190, 167; Meyer, Lecco (1883), Ber. 16, 2976.

20	grms.	aniline.
400	„	conc. hydrochloric acid.
15	„	sodium nitrite.
90	„	stannous chloride.

Twenty grms. pure commercial aniline are dissolved in 400 grms. conc. hydrochloric acid, and the resulting

luble in concentrated solutions of the alkalies ; easily soluble in alcohol, ether, and benzene. Phenylhydrazine may be used in determining the presence of the "carbonyl" group in a compound. (See p. 55.)

PREPARATION XXXVI.

CINNAMIC ACID, $C_9H_8O_2 = C_6H_5CH:CH.CO_2H$.
(*Phenylacrylic Acid*.)

LITERATURE.—Bertagnini (1856), Ann. Ch. Pharm. 100, 126 ; Perkin (1868), Chem. Soc. J. 21, 53 and 185 and (1886) 47, p. 317 ; Fittig (1881), Ber. 14, 1826, and (1885) Ann. Ch. Pharm. 227, 79.

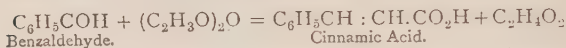
25 grms. benzaldehyde.

12·5 „ sodium acetate (anhydrous).

37·5 „ acetic anhydride.

Twenty-five grms. benzaldehyde, 12·5 grms. sodium acetate, previously fused and powdered, and 37·5 grms. acetic anhydride are mixed together in a flask connected to a reflux condenser and kept at a gentle boil on the oil-bath for about eight hours. On cooling, water is added to the dark-coloured viscid liquid and a slight excess of sodium carbonate, and any unchanged benzaldehyde distilled off with steam. After filtering from undissolved resinous by-products, the addition of hydrochloric acid precipitates the free

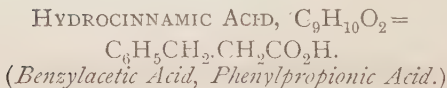
cinnamic acid in white crystalline flakes, which may be purified by recrystallisation from hot water.



The manner in which the reaction proceeds is still a disputed point (see Fittig, *Ann.* 227, 79, and Perkin, *Chem. Soc. J.* 30, 425, and 47, 317.)

Properties.—Colourless monoclinic prisms; m. p. 133°; b. p. 300—304°.

PREPARATION XXXVII.



LITERATURE.—Erlenmeyer, Alexejeff (1862), *Ann. Ch. Pharm.* 121, 375 and (1866) 137, 327.

10 grms. cinnamic acid.

100 „ water.

85 „ sodium amalgam (4 per cent.).¹

¹ *Preparation of Sodium Amalgam.*—Twenty grms. well pressed sodium cut into small pieces are introduced into 500 grms. dry mercury (previously warmed) contained in a large Messian crucible.* The formation of the amalgam is accompanied with evolution of heat and the sodium takes fire and burns. To prevent loss of mercury by spirting, the crucible is firmly closed with a lid. The solid amalgam is broken up into large pieces and preserved in a strong well-stoppered bottle.

Ten grms. cinnamic acid, to which 100 grms. water are added, are introduced into a stout flask or bottle of about $\frac{1}{4}$ litre capacity, and the liquid made slightly alkaline with caustic soda, which dissolves the greater part of the acid forming the sodium salt. A slight excess of the calculated quantity of 4 per cent. sodium amalgam (85 grms.) is added in small pieces from time to time, and the liquid thoroughly agitated. The solution, which remains clear, becomes slightly warm, and the amalgam soon liquefies; but no hydrogen is evolved until towards the end of the operation. When the whole of the amalgam has been added, and bubbles of gas cease to be given off, the alkaline solution containing the sodium salt of hydrocinnamic acid is poured off from the mercury, the latter is washed with water, and the washings added to the decanted portion. On acidifying the solution with hydrochloric acid, hydrocinnamic acid is precipitated as a colourless oil, which solidifies on cooling, and may be purified by crystallisation from water.



Properties.—Long colourless needles; m. p. 47° ; b. p. 280° ; soluble in water, alcohol, carbon bisulphide, and chloroform. Volatile in steam.

PREPARATION XXXVIII.

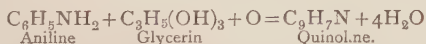
QUINOLINE, C_9H_7N .

LITERATURE.—Runge (1834), Pogg. Ann. 31, 65, 513 and 32, 318; Königs (1880), Ber. 13, 911; Skraup (1880), Monatsh. 1, 316 (1881), 2, 141; (1881) Ber. 14, 1002.

24	grms.	nitrobenzene.
38	„	aniline.
120	„	glycerin.
100	„	conc. sulphuric acid.

Twenty-four grms. nitrobenzene, 38 grms. aniline, and 120 grms. glycerin, are mixed together in a round-bottomed flask of $1\frac{1}{2}$ –2 litre capacity, and 100 grms. conc. sulphuric acid gradually added. The mixture is carefully heated on the sand-bath with reflux condenser until the reaction begins (10–15 minutes), *i.e.* until white vapours rise from the liquid. The flask is now raised from the sand-bath, and, when the reaction is over, replaced, and the contents gently boiled with inverted condenser for 2–3 hours. The dark-coloured product is diluted with water and unchanged nitrobenzene driven over with steam. The residue is made strongly alkaline with caustic soda, and the oily layer (quinoline and aniline) which separates, distilled off with steam. In order to eliminate the aniline present, the distillate is acidified with

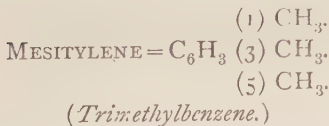
sulphuric acid and sodium nitrite added, until a sample of the liquid ceases to give the aniline reaction with bleaching powder solution. It is then boiled, whereby the aniline, converted into diazobenzene sulphate, is decomposed. The liquid is again made alkaline with caustic soda and submitted to a third distillation with steam. The distillate is extracted with ether, and, after driving off the ether, the residue is dehydrated over solid caustic potash, or potassium carbonate, and distilled.



The nitrobenzene acts as the oxidising agent.

Properties.—Colourless liquid; b. p. 237° ; sp. gr. 1.108 at 0° .

PREPARATION XXXIX.



LITERATURE.—Kane (1840), Journ. Prakt. Ch. 15, 129; Fittig, Brückner (1868), Ann. Ch. Pharm. 147, 43.

250 grms. acetone.

560 „ conc. sulphuric acid mixed
with $\frac{1}{2}$ volume of water.

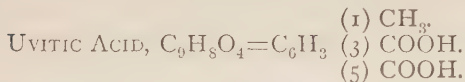
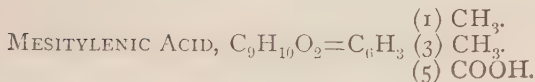
One pound dry sand is brought into a 2-litre retort connected with a condenser. Upon this 250 grms. acetone are poured, and from a tap funnel inserted through the tubulus, a cooled mixture of 560 grms. conc. sulphuric acid and 150 grms. water are slowly run in, in an uninterrupted stream, the retort being immersed in cold water in case the reaction becomes too violent. The liquid, which forms a homogeneous mixture, is allowed to stand twenty-four hours, whereby it gradually assumes a brown colour. It is then distilled. At first, unchanged acetone, water, and a small quantity of mesitylene pass over. As soon as oily drops are observed in the neck of the retort, the receiver is changed. A yellow oil, consisting chiefly of mesitylene, distils with the aqueous vapour. The distillation is continued until inconsiderable quantities of the oil appear. The liquid in the retort meantime changes to deep brown, and finally to black, with evolution of sulphurous acid fumes, and froths up considerably. The distillate divides into two layers; the upper yellowish layer containing mesitylene is separated from the lower layer of water, washed with caustic soda and water, and dehydrated over calcium chloride. It is then fractionated (100-200°; 200-300°). On the first distillation a very small quantity of mesitylene distils at its boiling-point; but after three or four fractionations over thin slices of metallic sodium about two-thirds of the portion distilling at

100-200° is obtained as pure mesitylene boiling constantly at 163°.



Properties.—Colourless, strongly refracting liquid; b. p. 163°; sp gr. .881 at 0°.

PREPARATION XL.



LITERATURE.—Fittig (1867), Ann. Ch. Pharm. 141, 144; Fittig, Brückner (1868), Ann. Ch. Pharm. 147, 292; Finck (1862), Ann. Ch. Pharm. 122, 184; Fittig, Furtenbach (1868), Ann. Ch. Pharm. 147, 295; Baeyer (1868), Zeitschr. 119.

20 grms. mesitylene.

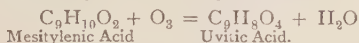
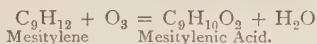
33 „ conc. nitric acid sp. gr. 1.4.

47 „ water

Twenty grms. mesitylene contained in a round-bottomed flask of $\frac{1}{4}$ litre capacity, connected with reflux

condenser, are oxidised by boiling with a mixture of 33 grms. nitric acid sp. gr. 1.4 and 47 grms. water. After heating the whole on the sand-bath for 16 to 20 hours, the oxidation, which occurs with evolution of nitrous fumes, is complete, and the hydrocarbon is converted into a white, difficultly soluble, strongly acid substance. On cooling, the mass is filtered, washed with cold water and separated from un-attacked mesitylene and also nitromesitylene by dissolving in sodium carbonate solution. On acidifying the alkaline solution with hydrochloric acid the acids are reprecipitated. Nitromesitylenic acid, which is also formed in the reaction, goes into solution on reduction with tin and strong hydrochloric acid. This operation must be conducted in a capacious flask, as the mass froths up, and should be heated for at least one hour, with constant shaking. On cooling, the undissolved portion is brought on to a filter, washed with cold water, dissolved in soda solution and reprecipitated from the hot filtered solution with hydrochloric acid. The white precipitate is a mixture of mesitylenic and uvitic acids. These are filtered and then separated from one another by distilling in steam. The distillation is continued until no further trace of mesitylenic acid appears in the condenser, and the distillate ceases to have an acid reaction. This occurs in the course of several hours. The larger portion of the

mesitylenic acid, free from uvitic acid, is contained suspended in the distillate, from which it may be separated by filtration. The filtrate is neutralised with soda solution, evaporated to a small bulk, precipitated with hydrochloric acid, and the usually somewhat yellow-coloured acid thus obtained united with the first portion. To purify it, the whole is redissolved in soda solution, and from the solution, filtered boiling hot, on the addition of hydrochloric acid in excess, colourless mesitylenic acid separates out, and by a single crystallisation from alcohol is pure. From the residual liquid in the distilling flask uvitic acid separates on cooling, containing traces only of mesitylenic acid, and is purified by recrystallisation from hot alcohol.



Properties. — *Mesitylenic Acid* — Colourless monoclinic crystals; m. p. 166°; with difficulty soluble in hot water, readily soluble in cold alcohol. *Uvitic Acid*—Colourless fine needles; m. p. 287 to 288°; insoluble in cold and hot water, readily soluble in alcohol and ether.

PREPARATION XLI.

TRIPHENYLMETHANE, $C_{19}H_{16} = CH (C_6H_5)_3$

LITERATURE.—Kekulé, Franchimont (1872), Ber. 5, 907; Hemilian (1874), Ber. 7, 1204; Friedel, Crafts (1877), Compt. rend. 1450; E. and O. Fischer (1878), Ann. Ch. Pharm. 194, 252; Schwarz (1881), Ber. 14, 1516; Friedel, Crafts (1882), Bull. Soc. Chim. 37, 6.

170 grms. benzene.

33 „ chloroform.

50 „ aluminium chloride.

Thirty-three grms. chloroform and 170 grms. benzene, both carefully dehydrated, are mixed together in a retort connected with a reflux condenser. Fifty grms. of aluminium chloride are added in portions of about 10 grms. at a time. On the addition of the chloride the reaction sets in spontaneously and the liquid begins to boil with copious evolution of hydrochloric acid. The aluminium chloride gradually dissolves, forming a dark brown oily liquid. When the aluminium chloride has been added, the mass is allowed to stand about twelve hours, and the reaction completed by heating for two hours on the sand-bath, when a further quantity of hydrochloric acid is evolved. The contents of the retort are cooled and poured into an equal volume of cold

water, which decomposes the aluminium triphenylmethane compound with evolution of heat and the free hydrocarbon dissolves in the excess of benzene with a reddish brown colour. The upper layer of benzene is separated from the aqueous portion, and the former dehydrated over calcium chloride. The excess of benzene is now distilled off on the water-bath, and the dark-coloured residual liquid fractionated up to 200° at the ordinary pressure, and finally *in vacuo*. This

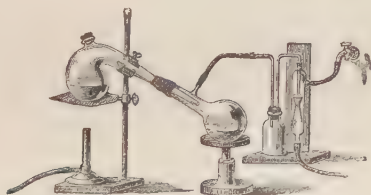
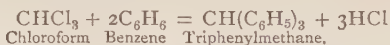


FIG. 19.

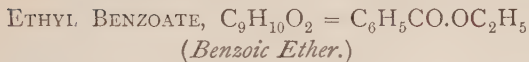
operation is conducted in the apparatus shown in Fig. 19, and consists of a retort and receiver, the latter being in connection with a water-jet aspirator. At first an oily liquid distils. This is impure diphenylmethane. When most of the diphenyl compound has passed over the distillation suddenly slackens. The receiver is now changed, and the contents of the retort more strongly heated. An orange-coloured oil passes over, which crystallises in the receiver. The distillation is continued until the

distillate no longer solidifies on cooling. A black resinous mass remains in the retort. The crude triphenylmethane in the receiver is recrystallised from hot benzene, forming a crystalline molecular compound with the solvent of the formula $C_{19}H_{16} \cdot C_6H_6$, which separates out on cooling as a yellow crystalline mass. This is again crystallised from benzene. By heating the substance on the water-bath it loses benzene and the triphenylmethane which remains is finally crystallised from hot alcohol.



Properties.—Brilliant colourless plates ; m. p. 92° ; b. p. 360° ; readily soluble in hot alcohol, in ether, and chloroform ; with difficulty in cold alcohol. On dissolving in cold, fuming nitric acid, pouring into water and treating the precipitate with zinc dust and glacial acetic acid, leucaniline is formed. This is precipitated with ammonia, and on gently warming the dry precipitate with a few drops of hydrochloric acid on a piece of platinum foil the magenta coloration is obtained from the formation of rosaniline hydrochloride.

PREPARATION XLII.



LITERATURE.—Carius (1859), Ann. Ch. Pharm. 110, 210.

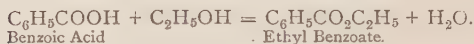
50 grms. alcohol (absolute).

25 „ benzoic acid.

Fifty grms. absolute alcohol and 25 grms. benzoic acid are mixed together in a flask of about 250 c.c. capacity fitted with a double-bored cork. Through one hole a small upright condenser is inserted, through the other a delivery tube passes, which dips below the liquid in the flask. Through the delivery tube a rapid current of hydrochloric acid gas is conducted into the mixture of alcohol and benzoic acid.* The gas is most conveniently generated by dropping conc. sulphuric acid from a tap funnel into a flask half-filled with conc. hydrochloric acid. The temperature of the mixture, as the gas passed in, rises to the boiling point of the alcohol, and the benzoic acid quickly dissolves. When the first reaction is over and the contents of the flask begin to cool again, the vessel is placed on the water-bath and the current of gas continued until fumes of the acid escape from the upper

end of the condenser. The contents of the flask are now poured into water, when a colourless oil falls to the bottom. The oil is shaken with dilute sodium carbonate solution to dissolve unattacked benzoic acid, then with water, separated as carefully as possible from the latter and dehydrated over ignited potassium carbonate. It is decanted and distilled.

The product boils nearly constantly at 211° .



Properties.—Colourless, oily liquid, with a pleasant fruity smell; b. p. 211.2° ; sp. gr. 1.0502. Treated with conc. ammonia it yields benzamide and alcohol; boiled with caustic potash it splits up into its original constituents, benzoic acid (potassium salt) and alcohol (hydrolysis or saponification).

PART II.

PREPARATION XLIII.

ETHYL BROMIDE, C_2H_5 Br.

LITERATURE—Serullas (1827), *Ann. Ch. Phys.* 34, 99;
Personne (1861), *Compt. rend.* 52, 468.

10 grms. amorphous phosphorus.

60 „ absolute alcohol.

60 „ bromine.

10 grms. amorphous phosphorus are placed in a dry round-bottomed flask of about $\frac{1}{2}$ litre capacity, connected with condenser and receiver, together with 60 grms. commercial absolute alcohol; 60 grms. bromine are slowly run in from a tap funnel, the flask being cooled if necessary during the operation. After standing for a few hours the mixture is distilled on the water-bath, the temperature of which is slowly raised (Fig. 20). The reddish distillate, consisting of ethyl bromide and alcohol, is shaken with double the volume of water to which soda solution is added

until slightly alkaline. The ethyl bromide, which sinks to the bottom of the vessel, is drawn off by a tap funnel, and is then shaken repeatedly with water. It is separated as completely as possible from water and dehydrated over pieces of fused calcium chloride. The

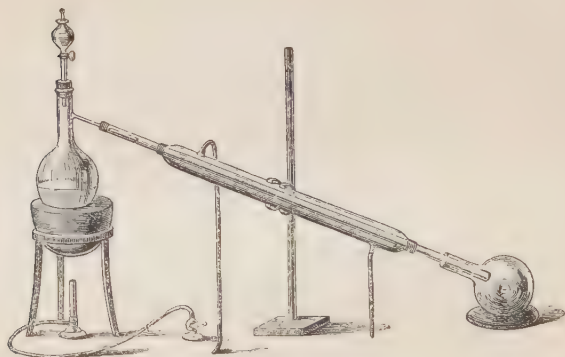
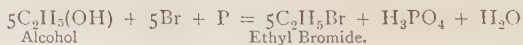


FIG. 20.

clear liquid after being decanted is distilled on the water-bath, a thermometer being inserted through the cork of the distilling flask. The ethyl bromide distils at $36-40^{\circ}$ and may be further purified by a second distillation.



Properties.—Colourless liquid; b. p. 38.8° ; sp. gr. 1.47 at 13.5° .

Determination of Specific Gravity.—A simple method for determining the specific gravity of liquids is as follows: A small glass bottle of about 20—30 c.c. capacity, which can be readily made by the help of the blow-pipe (Fig. 21), is fitted with a cork. The neck of the vessel just above the bulb is narrowed by drawing it out in the flame, and a horizontal mark *m*



FIG. 21.

etched or scratched on it with a file. The bottle is thoroughly cleaned, dried in the air-bath, allowed to cool and weighed. It is then filled with the liquid, which is poured in through a funnel, the stem of which is drawn out so as to pass through the constricted neck. The bottle is placed in a mixture of snow or pounded ice and a little water and left $\frac{1}{4}$ to $\frac{1}{2}$ hour until the contents have a temperature of 0° . The meniscus is now

adjusted until it coincides with the mark on the neck of the bottle. If more liquid has to be added this may be done from a small pipette with capillary delivery tube; if some of the liquid has to be removed a piece of bibulous paper may be used to absorb it. The bottle is then corked, dried, allowed to remain $\frac{1}{4}$ hour in the balance case and weighed. It is then emptied, cleaned and dried and filled with distilled water previously boiled. The water is cooled to 0° , the meniscus adjusted and the bottle weighed, the same process being repeated as that just described. The following expression will give the specific gravity of the liquid at 0° compared with water at 4° and reduced to a vacuum.

$$S = \rho \frac{W_3 - W_1}{W_2 - W_1} + \sigma \frac{W_2 - W_3}{W_2 - W_1}$$

Where W_1 = apparent weight of the empty bottle.

W_2 = ,, ,, bottle and water
 at 0°

W_3 = apparent weight of the bottle and liquid
 at 0°

ρ = density of water at 0° = '999873.

σ = density of air at t° (temperature of the balance room).

A very delicate and useful piece of apparatus, which is readily made with the blow-pipe, is Perkin's modification of Sprengel's specific gravity tube (*Chem.*

Soc. J. 45, 421). It is especially adapted for small quantities of liquid and for the more volatile ones. The apparatus (Fig. 22) consists of a U-tube to hold from 2 to 10 c.c., drawn out at each end into a fine capillary. The one capillary limb (α) is bent

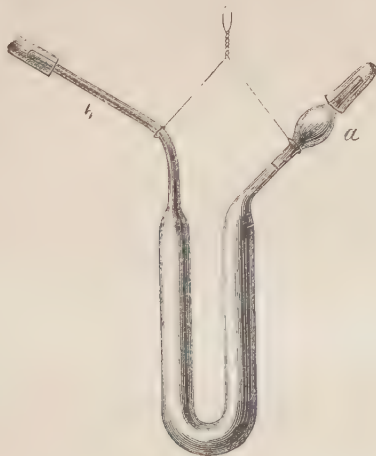


FIG. 22.

outwards and is furnished with a small bulb, the other (b) is bent at a right angle with the first. On the limb α , between the bulb and the top of the U-tube, a mark is scratched. The tube is dried and weighed, and the liquid drawn in through the limb b until it half fills the small bulb on the limb α . The apparatus

is cooled in pounded ice, and the meniscus adjusted to the mark on *a* by tilting the tube until the limb *b* has a horizontal position. To the end of this limb a piece of bibulous paper is applied until the liquid sinks to the desired position in the limb *a*. The U-tube is then brought to a vertical position, loose glass caps placed over the ends of the two limbs, the apparatus carefully dried, allowed to stand and weighed. The operation is then repeated with distilled water. An experiment with ethyl bromide gave the following results :

Weight of the tube empty		6.242	grms.
„	„ + ethyl bromide at 0°	9.472	„
„	„ + water at 0°	8.417	„
$S = .99873 \times \frac{3.230}{2.175} = 1.485$			

The correction for weight in air is so small that it may here be neglected.

PREPARATION XLIV.

ETHER, $C_4H_{10}O = C_2H_5OC_2H_5$.
(*Sulphuric Ether. Ethyl Oxide.*)

LITERATURE.—V. Cordus 1544; Boullay (1813), Journ. Pharm. 1, 97; Williamson (1850) Phil. Mag. (3), 37, 350.

300 grms. conc. sulphuric acid.
170 „ alcohol 90 per cent.

A mixture of 300 grms. conc. sulphuric acid and 170 grms. alcohol, 90 per cent. are heated to 140° in a round-bottomed flask on wire gauze by means of a Bunsen lamp. The flask is closed with a cork pierced with 3 holes. Through one of these a thermometer is inserted and dips into the liquid; through the second

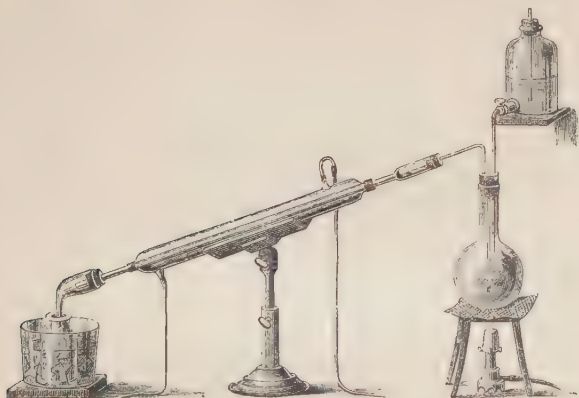
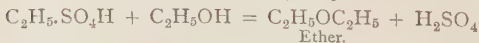
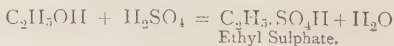


Fig. 23.

a tube is fitted which reaches just above the surface of the liquid and is attached at its upper end with a vessel containing alcohol (Fig. 23). A bent tube passing through the third hole connects the flask with a long condenser and receiver, both of which must be kept well cooled during the operation.

When the temperature of the mixture reaches 140° , 90 per cent. alcohol is run in from the reservoir of alcohol in proportion to the quantity of liquid which distils. The temperature must be maintained constant at $140\text{--}145^{\circ}$, which is easily effected by regulating the supply of alcohol. When about treble the quantity of alcohol contained in the original mixture has been converted into ether the distillation is stopped. The liquid in the receiver consists of two layers, and contains in addition to ether, alcohol, water and sulphurous acid. The ethereal layer is drawn off, washed with dilute soda solution, then repeatedly with water, and is dehydrated over pieces of fused calcium chloride. It is rectified on the water-bath. The ether thus purified still contains traces of alcohol and water, which it obstinately retains, and from which it can only be freed by a further treatment with metallic sodium (see p. 5). The ether may be finally distilled on the water-bath over fresh metallic sodium. The receiver in which the ether collects should be cooled with ice, and a calcium chloride tube attached to it to prevent absorption of moisture during the distillation.



On heating alcohol and sulphuric acid, ethyl sulphate is first formed with elimination of water. In the second phase of the

reaction, which occurs at 140° , a second molecule of alcohol is decomposed with the formation of ether, sulphuric acid being regenerated, and the latter can again convert a fresh quantity of alcohol into ether.

Properties.—Colourless, mobile liquid ; b. p. 35° ; sp. gr. $\cdot 713$ at 20° ; burns with a luminous flame. Not miscible with water ; 9 parts water dissolve 1 part ether.

PREPARATION XLV.

CHLOROFORM, CHCl_3

LITERATURE.—Liebig (1831), Pogg. Ann. 23, 444 ; Soubeiran (1832), Ann. Ch. Phys. (2), 48, 131 ; Dumas (1834), Ann. Ch. Phys. 56, 115.

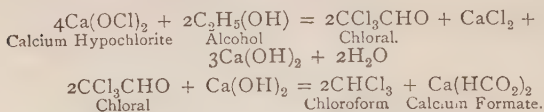
200 grms. bleaching powder.

800 „ water.

33 „ alcohol sp. gr. $\cdot 834$.

Two hundred grms. bleaching powder, 800 grms. water and 33 grms. dilute alcohol are placed in a round-bottomed flask connected with a condenser and well mixed into a paste. The mass is carefully heated over wire gauze, preferably with a rose burner. As soon as the reaction begins, the burner is removed and chloroform and water commence to distil over into the receiver, where the former settles to the bottom as a heavy oil. The chloroform is freed from alcohol by shaking with

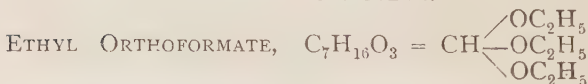
water and dehydrated over calcium chloride. It is finally rectified on the water-bath.



The formation of chloroform is here due to a secondary reaction. By the action of bleaching powder on alcohol, chloral is first formed, which decomposes in presence of the calcium hydrate of the bleaching powder into chloroform and calcium formate.

Properties.—Colourless liquid possessing an ethereal odour and sweet taste; b. p. 62° ; sp. gr. 1.525 at 0° ; does not burn.

PREPARATION XLVI.



LITERATURE—Williamson, Kay (1854), *Proc. Roy. Soc.* 7, 135; Basset (1864), *Chem. Soc. J.* (2) 198; Ladenburg, Wichelhaus (1869), *Ann. Ch. Pharm.* 152, 164; Deutsch (1879), *Ber.* 12, 116.

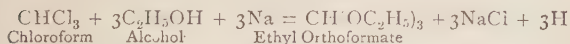
100 grms. chloroform.

117 „ absolute alcohol.

58.5 „ sodium.

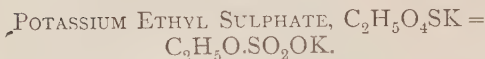
58.5 grms. metallic sodium well pressed between filter paper and cut into thin slices are placed in a

dry retort of about $1\frac{1}{4}$ litre capacity and covered with a layer of ether. The retort is connected with a spiral condenser. A mixture of 100 grms. anhydrous chloroform and 117 grms. absolute alcohol are added drop by drop from a tap funnel. At the commencement the reaction proceeds rather violently and the retort must be well cooled with ice. The clear liquid becomes gradually thick from the separation of sodium chloride and changes to a brown colour. The reaction is completed by warming the mass on the water-bath with inverted condenser until the whole of the sodium is converted into sodium chloride. The contents of the retort are poured into water whereby the ethyl orthoformate dissolved in the ether separates out on the surface of the water in the form of a brown liquid. The ethereal solution is drawn off, well washed with water, separated from the aqueous layer and dehydrated over calcium chloride. It is then distilled on the water-bath, and when no further liquid passes over the distillation is continued over the bare flame. The distillate passing over above 110° is redistilled and the orthoformic ether is then pure.



Properties—Colourless liquid; b. p. $145-147^{\circ}$; sp. gr. $\cdot 8964$.

PREPARATION XLVII.

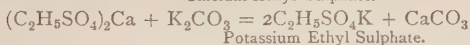
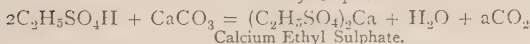
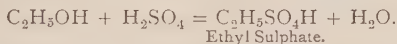


LITERATURE.—Berthelot (1855), *Ann. Ch. Phys.* (3) 43, 385; Claesson (1879), *Journ. Prakt. Ch.* (2) 19, 246.

500 grms. absolute alcohol
375 „ conc. sulphuric acid.

To 500 grms. commercial absolute alcohol contained in a porcelain basin about $1\frac{1}{2}$ litre capacity, 375 grms. conc. sulphuric acid are slowly added and the two layers quickly mixed, whereby the temperature rises to $80-90^\circ$. The mixture is heated for some time on the water-bath. The product then contains in addition to the acid ether, free sulphuric acid and unchanged alcohol. On cooling, the liquid is diluted by first adding ice to prevent any great increase of temperature, and then water. It is neutralised with chalk ground into a paste with water. The filtered solution of calcium ethyl sulphate made slightly alkaline with lime water, may be concentrated on the water-bath without fear of decomposition. By adding a concentrated solution of potassium carbonate until the calcium is just precipitated, the soluble potassium salt of ethyl sulphate is formed, which is separated by filtration from the precipitated calcium carbonate.

The clear solution, with the addition of a small quantity of potassium carbonate, can be evaporated without decomposition on the water-bath until crystallisation begins. By slowly concentrating the liquid a well crystallised product may be obtained.



Properties.—Colourless, foliated crystals; easily soluble in water and dilute alcohol; insoluble in absolute alcohol and ether.

PREPARATION XLVIII.

PROPIONITRIL, $\text{C}_3\text{H}_5\text{N} = \text{C}_2\text{H}_5\text{CN}$.

(*Ethyl Cyanide.*)

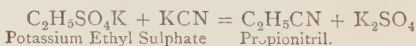
LITERATURE.—Pelouze (1834), Ann. Ch. Pharm. 10, 249; Linnemann (1868), Ann. Ch. Pharm. 148, 252; Rossi (1871), Ann. Ch. Pharm. 159, 79.

50 grms. potassium ethyl sulphate

50 „ potassium cyanide.

Fifty grms. finely powdered potassium ethyl sulphate dried at 100° and 50 grms. dry powdered commercial potassium cyanide are thoroughly mixed

and introduced into an iron tube closed at one end, which is one-third filled with the mixture. A small channel is formed along the upper surface to allow the gaseous products to escape by tapping the tube horizontally. The tube is placed in a combustion furnace, the open end of which should project about 3 cm. from the furnace (Fig. 17) and is connected with a condenser and receiver. The mixture is carefully subjected to dry distillation, beginning at the front end and proceeding gradually towards the closed end of the tube. The yellowish brown oily distillate, which possesses an unpleasant smell, is re-distilled, and the portion passing over below 110° and consisting of propionitril, isopropionitril, alcohol, and water, collected. Isopropionitril is dissolved out by shaking the distillate with a small quantity of conc. hydrochloric acid. The oil floating on the surface of the acid is separated, washed with a small quantity of water, dehydrated with calcium chloride and anhydrous potassium carbonate, and then distilled. The propionitril dissolved in the washings may be separated by adding calcium chloride.



Properties.—Colourless liquid having a peculiar ethereal smell; b. p. 98° ; sp. gr. 0.789 at 12° ; somewhat soluble in water.

PREPARATION XLIX.

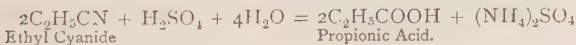
PROPIONIC ACID, $C_3H_6O_2 = CH_3 \cdot CH_2 \cdot CO \cdot OH$.

LITERATURE.—Gottlieb (1844), *Ann. Ch. Pharm.* **52**, 127; Frankland, Kolbe (1848), *Chem. Soc. J.* **1**, 60; *Ann. Ch. Pharm.* **65**, 269; Williamson (1853), *Phil. Mag.* (4) **6**, 204; Rossi (1871), *Ann. Ch. Pharm.* **159**, 79; Beckurts, Otto (1877), *Ber.* **10**, 262.

50 grms. propionitril

150 „ mixture of $\left\{ \begin{array}{l} 2 \text{ vol. water and } 3 \text{ vol.} \\ \text{conc. sulphuric acid.} \end{array} \right.$

To 50 grms. ethylcyanide contained in a round-bottomed flask of about $1\frac{1}{2}$ litre capacity, and connected with a reflux condenser, 150 grms. of a mixture of 2 vol. water and 3 vol. conc. sulphuric acid are slowly added and allowed to stand for some time. The mixture is then heated to 100° without disconnecting the condenser. The originally clear liquid becomes cloudy owing to the separation of propionic acid, which is insoluble in the solution of ammonium sulphate formed during the reaction. When no more oil separates out on the surface of the liquid (with 50 grms. of the cyanide about 12 hours heating is necessary) the reaction is complete. After allowing the liquid to cool down to 50° , the almost colourless acid is separated and purified by distillation.



Properties.—Colourless liquid possessing a smell similar to that of acetic acid; b. p. 140.7° ; sp. gr. 1.016 at 0° ; soluble in water; the acid may be separated from its aqueous solution as an oily layer by the addition of calcium chloride.

PREPARATION I.

ETHYLENE DIBROMIDE, $C_2H_4Br_2 = CH_2Br.CH_2Br$

LITERATURE.—Balard (1826), Ann. Ch. Phys. (2) 32, 375; Erlenmeyer, Bunte (1873) Ann. Ch. Pharm. 168, 64; Erlenmeyer (1878), Ann. Ch. Pharm. 192, 244.

25 grms. alcohol

150 „ conc. sulphuric acid.

A mixture of 25 grms. strong alcohol and 150 grms. conc. sulphuric acid are heated in a 2-litre round-bottomed flask on a sand-bath until ethylene vapour is evolved in a steady stream. A mixture of 1 part alcohol and 2 parts conc. sulphuric acid are run into the flask through a tap funnel at such a speed that the stream of gas continues without interruption, and at the same time without causing the contents of the vessel to froth up too violently. The gas is purified from alcohol, ether, sulphurous acid, and carbonic acid, by conducting it through a series of Woulff's bottles fitted with safety tubes and connected with the generating flask (Fig. 24). The first of these

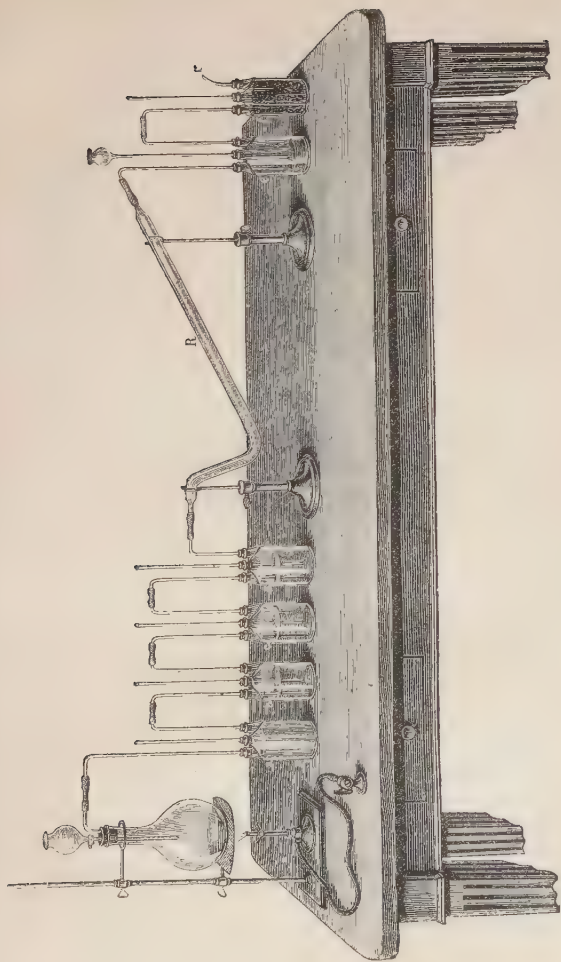
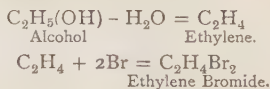


FIG. 24.

bottles (*a*) is empty, the second (*b*) contains conc. sulphuric acid, the third (*c*) and fourth (*d*) dilute caustic soda solution. Thus purified, the ethylene passes into a long bent tube (R)¹ and a Woulff's bottle (*e*), which contain bromine covered with a layer of water. The tube (R) contains 150 grms. bromine and 1 c.c. water, and the bottle (*e*) 50 grms. bromine and 1 c.c. water. The last bottle is filled to a height of 5 cm. with broken glass, and then with lumps of dry soda-lime. As soon as the bromine assumes a pale yellow tint by absorption of ethylene and conversion into ethylene bromide, the evolution of gas is interrupted or the liquid removed and a fresh quantity of bromine introduced. The crude ethylene bromide is shaken with dilute caustic soda solution, washed with water, separated from the aqueous layer and dehydrated over calcium chloride. After decanting from the calcium chloride it is rectified.



Properties.—Colourless liquid which solidifies at 0° to a crystalline mass and melts at 9°; b. p. 129.5°; sp. gr. 2.17 at 20°.

¹ This may be replaced by a Woulff bottle, and cooled if necessary in cold water.

PREPARATION LI.

ETHYLENE ALCOHOL, $C_2H_6O_2 = CH_2(OH).CH_2(OH)$.
(*Ethylene Glycol*.)

LITERATURE.—Wurtz (1856), *Compt. rend.* 43, 199; Atkinson (1858), *Phil. Mag.* (4), 16, 433; Simpson (1859), *Proc. Roy. Soc.* 9, 725; Erlenmeyer (1874), *Ann. Ch. Pharm.* 173, 117 and (1875) 177, 145 and (1878) 192, 244; Zeller, Hüfner (1874), *Journ. Prakt. Ch.* (2) 10, 271 and (1875) (2) 11, 229.

188 grms. ethylene bromide,
138 „ potassium carbonate,
1 litre water.

One hundred and eighty-eight grms. ethylene bromide, 138 grms. potassium carbonate, and 1 litre water are heated to boiling in a 2-litre round-bottomed flask on the sand-bath with reflux condenser. The boiling is continued until the whole of the ethylene bromide has disappeared which occurs in about 10 hours. Carbonic acid and vinyl bromide (C_2H_3Br) are evolved. The latter may be collected as monobromethylene bromide by attaching to the upper part of the condenser a Liebig bulb apparatus containing bromine. When the reaction is finished, the contents of the vessel, while still warm, are poured into a porcelain basin and carefully concentrated on the water-bath until potassium bromide begins to separate out in considerable quantity. The cooled

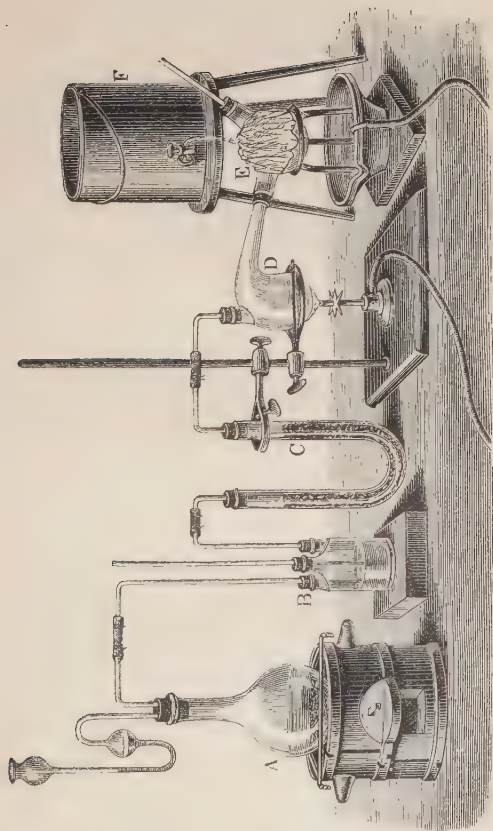
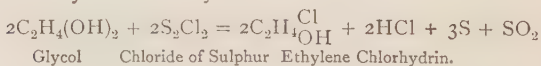


FIG. 25.

Two hundred and fifty grms. chloride of sulphur are added to 100 grms. glycol boiling at 196–198° contained in a dry round-bottomed flask of about $\frac{3}{4}$ -litre capacity, and the mixture is heated on the water-bath with a reflux condenser until the evolution of hydrochloric acid ceases, an operation which requires three or four days.* After cooling, the contents of the flask are extracted several times with ether, which readily dissolves out the chlorhydrin and the ethereal solution is decanted from precipitated sulphur. It is shaken for a time with moist potassium carbonate. The ether is then distilled off on the water-bath, and the distillation continued over a lamp. The portion, which passes over at 128–131°, is nearly pure ethylene chlorhydrin.



Properties.—Colourless liquid; b. p. 130–131°; sp. gr. 1.24 at 8°.

$\frac{1}{2}$ litre capacity connected with a receiver furnished with an exit tube. Into the melted sulphur, chlorine, dried by passing through conc. sulphuric acid and fused calcium chloride, is conducted, and chloride of sulphur distils over (Fig. 25). When the greater portion of the sulphur has been converted into chloride the evolution of gas is stopped. In the receiver a brownish yellow liquid collects, and is redistilled. The portion passing over at 138°–139° is pure chloride of sulphur.

Properties.—A reddish-yellow liquid; b. p. 139°; sp. gr. 1.68. Fumes in the air, and decomposes with water into sulphurous acid, hydrochloric acid, and water. This liquid is best preserved in sealed vessels.

PREPARATION LIII.

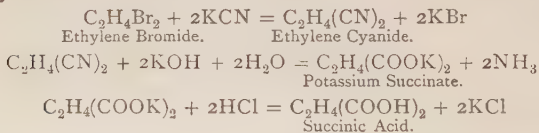
SUCCINIC ACID, $C_4H_6O_4 = COOH.CH_2.CH_2.COOH$.
(*Ethylenedicarboxylic Acid*.)

LITERATURE.—Simpson (1860), Proc. Roy. Soc. 10, 574; Geuther (1861), Ann. Ch. Pharm. 120, 268.

100 grms. ethylene bromide,
75 „ potassium cyanide.

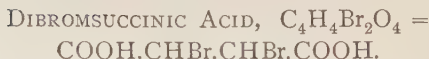
One hundred grms. ethylene bromide and 75 grms. potassium cyanide in alcoholic solution are heated together on the water-bath in a round-bottomed flask of about $\frac{3}{4}$ -litre capacity connected with reflux condenser. This process is continued until the potassium cyanide is converted into bromide, which separates out from the solution. To the alcoholic solution, filtered from potassium bromide, the calculated quantity of caustic potash (about 70 grms.) is added, and the mixture is heated on the water-bath with an upright condenser until the strong evolution of ammonia gas begins to slacken. The cooled contents of the flask are acidified with dilute hydrochloric acid and carefully evaporated to dryness. The dry powdered residue is extracted several times with absolute alcohol. On distilling off the alcohol the succinic acid remains behind in small crystals. The product, which is slightly coloured, is re-crystal-

lised from hot water (with the addition, if necessary, of animal charcoal) and, on cooling, forms colourless crystals.



Properties.—Colourless prisms which sublime above 100° without decomposition; m. p. 180° ; at 235° the acid decomposes forming the anhydride; soluble in water, alcohol, and ether; insoluble in chloroform.

PREPARATION LIV.



LITERATURE.—Kekulé (1861), Ann. Ch. Pharm. 117, 120 and (1861) Spt. 1, 351; Burgoin (1873), Bull. Soc. Chem. 19, 148.

12 grms. succinic acid.
 33 „ bromine.
 12 „ water.

Twelve grms. succinic acid, 32 grms. bromine, and 12 grms. water are heated in a sealed tube with capillary end, on the air-bath, for six hours at 170°

(Fig. 26). On cooling, the tube is opened by wrapping it tightly in a cloth and softening the capillary end

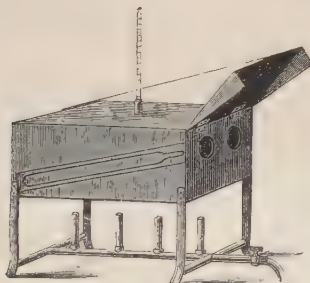


FIG. 26.

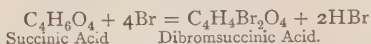
in the flame, when the pressure of gas within forces an outlet (Fig. 27). Hydrobromic acid escapes.



FIG. 27.

The red colour of the bromine has completely disappeared, and the tube is filled with a solid greyish white mass. By recrystallising the product from

boiling water, with the addition of a little animal charcoal, dibromsuccinic acid is obtained pure, in perfectly colourless well-defined crystals.



Properties.—Colourless glistening crystals; difficultly soluble in cold, more readily in hot water, soluble in alcohol and ether; decompose at 200° , with formation of hydrobromic acid and brommaleic acid.

PREPARATION LV.

ACETALDEHYDE, $\text{C}_2\text{H}_4\text{O} = \text{CH}_3\text{CHO}$.
(*Aldehyde.*)

LITERATURE.—Liebig (1835), Ann. Ch. Pharm. 14, 133; Staedeler (1859), Journ. Prakt. Ch. (1), 76, 54.

210 grms. potassium dichromate.
840 „ water.
210 „ alcohol (90 per cent.).
280 „ conc. sulphuric acid.

Two hundred and ten grms. potassium bichromate broken into pieces, about the size of a coffee bean, and 840 grms. water are placed in a round-bottomed flask of about 3 litre capacity, connected with a con-

denser and receiver, the latter being well cooled with ice. To the cooled mixture a solution of 210 grms. alcohol (90 per cent.) and 280 grms. conc. sulphuric acid, also well cooled, is slowly added from a tap-

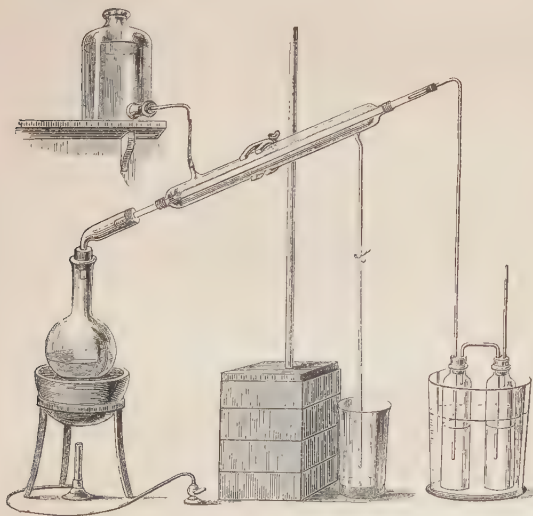


Fig. 28.

funnel, and the flask well shaken. A considerable evolution of heat occurs, the liquid becomes green, and water, alcohol, and aldehyde distil over into the receiver. The distillate is again rectified on the water

bath at a gentle heat (about 50°), and the vapours are led into an inverted condenser, in which the water is maintained at a temperature of $25-30^{\circ}$. Alcohol and aqueous vapour condense in the tube, the aldehyde, on the other hand, passes by a bent tube (preferably with a bulb about the middle to prevent ether being drawn over into the flask) into two vessels half filled with anhydrous ether (Fig. 28). The aldehyde

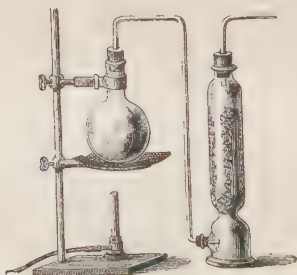
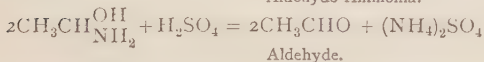
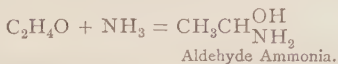
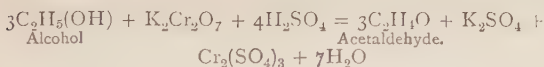


FIG. 29.

readily dissolves in the ether. If the ethereal solution be now saturated with ammonia gas, previously dried through quicklime (Fig. 29), the whole of the aldehyde separates out in the form of aldehyde ammonia as a white crystalline body. It is separated from the mother-liquor by draining well at the filter-pump, repeatedly washing with ether, and finally drying the crystals on bibulous paper over calcium

chloride. From the aldehyde-ammonia thus obtained pure aldehyde may be prepared. The crystals are dissolved in an equal weight of water, and distilled on the water-bath with a mixture of $1\frac{1}{2}$ parts conc. sulphuric acid and 2 parts water, the receiver, which is attached to the condenser, being cooled with ice.

The temperature of the water-bath is gradually raised until the water begins to boil, and the distillation is then interrupted. The distillate is dehydrated over an equal bulk of calcium chloride in coarse lumps, and again distilled over calcium chloride, the temperature of the water-bath being raised to 30° . The anhydrous acetaldehyde is kept in sealed tubes.



Properties.—Colourless liquid; b. p. 21° ; sp. gr. '807 at 0° ; soluble in water, alcohol, and ether; it has a strong reducing action, and precipitates metallic silver from ammoniacal silver solution in the form of a mirror.

PREPARATION LVI.

ACETYL CHLORIDE, $C_2H_3O.Cl = CH_3CO.Cl$.

LITERATURE.—Gerhardt (1853) Ann. Ch. Phys. (3) 37, 285, Béchamp (1855), Compt. rend. 40, 944; and (1856) 42, 224; Fittig (1886), Grundriss der Org. Chem. p. 116.

135 grms. glacial acetic acid.

90 „ phosphorus trichloride.¹

One hundred and thirty-five grms. glacial acetic acid and 90 grms. phosphorus trichloride are mixed

¹ *Preparation of Phosphorus Trichloride.**—A retort of about $\frac{3}{4}$ litre capacity, the bottom of which is covered with a thin layer of dry sand, is connected with a receiver provided with an exit tubulus. One hundred grms. dry phosphorus in the form of small cubical pieces (it is cut in a mortar under water) are then introduced, over the surface of which chlorine gas is conducted. The phosphorus takes fire in the chlorine and burns with a lambent flame, forming phosphorus trichloride which collects in the well-cooled receiver. In the course of the operation, and while the chlorine is passing through at a good speed, the sides of the vessel must remain transparent. The chlorine inlet tube is movable in the cork, so that it may be raised or lowered readily. If the tube is too close to the surface of the phosphorus the latter becomes so strongly heated that dense fumes are evolved which cover the upper part of the retort with a layer of red phosphorus; and if, on the other hand, the tube is too far removed, phosphorus pentachloride is formed, which forms a yellow crystalline crust on the sides of the vessel. The position of the tube must be regulated so that neither the one nor the other reaction occurs. If a red deposit forms the tube must be slightly raised, if the pentachloride is produced it is lowered. The distillate is then rectified on the water-bath.

together in a dry round-bottomed flask of $\frac{1}{2}$ to $\frac{3}{4}$ litre capacity, the flask being well cooled.* The flask, to which a reflux condenser is now attached, is heated to about 40° on the water-bath.* When the evolution of hydrochloric acid gas has nearly ceased, the contents of the flask are distilled on the water-bath, the receiver being cooled in ice and provided with a calcium chloride tube to prevent absorption of moisture. Acetyl chloride collects in the receiver as a colourless liquid, which, after redistillation, is nearly pure, and should be kept in sealed vessels.

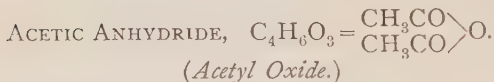


Properties.—Colourless liquid; b. p. 55° ; sp. gr. 1.1305 at 0° ; decomposes with water, forming hydrochloric acid and acetic acid, and therefore fumes in moist air.

The same arrangement of apparatus is employed as shown in Fig. 25. For the preparation of chlorine a mixture of broken pieces of pyrolusite and comm. conc. hydrochloric acid (heated preferably in an earthenware vessel in the water-bath) or a mixture of equal parts of powdered salt (600 grms.) and powdered manganese dioxide (600 grms.) may be employed. The latter is introduced into a round-bottomed flask of about 6 litres capacity, and a cooled mixture of 1440 grms. conc. sulphuric acid and 720 grms. water added. When the evolution of chlorine slackens the flask is heated on the sand-bath.

Properties.—Colourless liquid; b. p. 74° ; sp. gr. 1.616 at 0° ; fumes in moist air, decomposes into phosphorus acid and hydrochloric acid.

PREPARATION LVII.

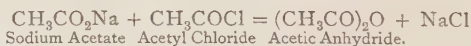


LITERATURE.—Gerhardt (1853), Ann. Ch. Phys. (3) 37, 311; Kanonikoff, Saytzeff (1877), Ann. Ch. Pharm. 185, 192.

100 grms. sodium acetate (fused).

100 „ acetyl chloride.

One hundred grms. anhydrous and powdered sodium acetate are introduced into a retort of about $\frac{1}{2}$ litre capacity, connected with a condenser and receiver, 100 grms. acetyl chloride are then slowly added, drop by drop, from a tap-funnel, the retort being well cooled.* When the reaction, which proceeds at the ordinary temperature, has ceased, the vessel is first heated on the water-bath and the anhydride is then distilled off on the sand-bath. The distillate is rectified, and the portion passing over at $135-140^\circ$ collected. By a further distillation the pure anhydride is obtained, which must be kept in well-stoppered bottles.



Properties.—Colourless liquid, having an irritating smell; b. p. 138° ; sp. gr. 1.097 at 0° ; decomposes rapidly in presence of water into acetic acid.

PREPARATION LVIII.

ACETAMIDE, $C_2H_5NO = CH_3CO.NH_2$

LITERATURE.—Dumas (1847), *Compt. rend.* 25, 657; Kündig (1858), *Ann. Ch. Pharm.* 105, 277; Smit (1875), *Bull. Soc. Chim.* 24, 540; Hofmann, Buckton (1856), *Ann. Ch. Pharm.* 100, 131; Hofmann (1882), *Ber.* 15, 981.

200 grms. ammonium acetate.

Two hundred grms. ammonium acetate (prepared by passing ammonia gas, dried through quicklime (see Fig. 29) into about 160 grms. glacial acetic acid, and neutralising if necessary with conc. ammonia) are heated for from 5 to 6 hours in sealed tubes to 230°. Tubes made from the usual thick-walled tubing may be filled half full of the salt without risk of bursting. The tubes then contain an oily-looking liquid, consisting of an aqueous solution of ammonium acetate, together with a large quantity of acetamide. The contents are distilled, and the portion boiling above 180° collected apart. This distillate, on standing, almost completely solidifies to a colourless crystalline mass. It is freed from mother-liquor by draining at the filter-pump, and purified by a second distillation.

The acetamide has then a nearly constant boiling point.



Properties. — Colourless rhombohedral crystals having a peculiar smell; m. p. 82° ; b. p. 222° ; easily soluble in water and alcohol.

PREPARATION LIX.

METHYLAMINE HYDROCHLORIDE, $\text{CH}_6\text{NCl} =$
 $\text{CH}_3\text{NH}_2\text{HCl}.$

LITERATURE.—Wurtz (1848), *Compt. rend.* 28, 223; Hofmann (1849), *Ann. Ch. Pharm.* 73, 91; Mendius (1862), *Ann. Ch. Pharm.* 121, 129; Hofmann (1882), *Ber.* 14, 2725 and (1883) *Ber.* 15, 407 and 762; Tafel (1886), *Ber.* 19, 1924.

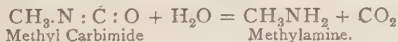
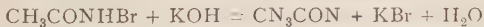
20 grms. acetamide.

54 „ bromine.

56 „ caustic potash.

A 10 per cent. solution of caustic potash (about 20 grms.) is added in the cold to 20 grms. acetamide, previously dissolved in 54 grms. bromine, until the dark brown liquid changes to a deep yellow colour. The solution, which now contains potassium bromide and acetmonobromamide, is slowly added from a tap-funnel inserted, together with a thermometer,

into the tubulus of a retort ($\frac{1}{2}$ litre capacity) which contains a concentrated solution of 56 grms. caustic potash heated to 60—70°. Heat is evolved, and care must be taken that the rise of temperature does not greatly exceed the above limits. The reaction goes on quietly, and the yellow solution is gradually de-colourised. The mixture is then digested for a short time at the above temperature until the yellow colour completely disappears, and the liquid distilled with a naked flame. The vapours of methylamine and ammonia which are evolved are passed into dilute hydrochloric acid contained in the receiver. When the methylamine has been driven over, the hydrochloric acid solution is evaporated to dryness on the water-bath, and the colourless crystalline residue extracted repeatedly with small quantities of absolute alcohol, which dissolves out the methylamine salt from the ammonium chloride. From the hot alcoholic solution foliated crystals separate out on cooling.



Properties.—Large deliquescent tablets, which melt at 200°, and sublime above 220° with slight decomposition. The base is liberated, on warming with caustic soda, as an inflammable gas.

PREPARATION LX.

(I.)

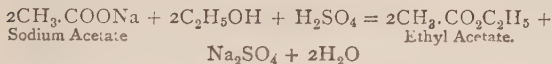
ETHYL ACETATE, $C_4H_8O_2 = CH_3CO_2C_2H_5$.
(*Acetic Ether.*)

LITERATURE.—Frankland, Duppa (1865), Phil. Trans. 156, 37; Eghis (1873), Ber. 6, 1177; Pabst (1880), Bull. Soc. Chim. 33, 350.

100 grms. sodium acetate (fused).
60 „ alcohol (97 per cent.)
150 „ conc. sulphuric acid.

One hundred grms. fused and coarsely powdered sodium acetate are slowly added to a cooled mixture of 60 grms. alcohol 97 per cent. and 150 grms. conc. sulphuric acid contained in a round-bottomed flask of about $\frac{1}{2}$ litre capacity and connected with a condenser and receiver. After standing about two hours the produce is distilled first on the water-bath and finally over the naked flame. The ethyl acetate is separated from the distillate, which contains in addition, acetic acid, alcohol, ether and sulphurous acid, by shaking up with a concentrated solution of soda or brine. The upper layer of liquid is removed, dehydrated over calcium chloride and distilled on the water-bath. The portion distilling below 74° contains

ether, that boiling at 74—79°, which is principally ethyl acetate, is separately collected and purified by redistillation.



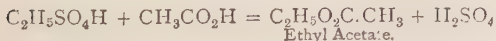
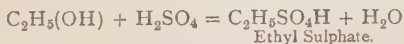
(2.)

50 c.c. conc. sulphuric acid.

50 „ alcohol 96 per cent.

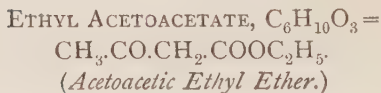
Mixture of equal volumes of acetic acid 93 per cent. and alcohol 96 per cent.

A mixture of 50 c.c. conc. sulphuric acid and 50 c.c. alcohol 96 per cent. contained in a round-bottomed flask of about $\frac{1}{2}$ litre capacity and connected with condenser and receiver is heated to 130° and a mixture of equal volumes of acetic acid 93 per cent. and alcohol 96 per cent. is slowly added from a tap funnel in a continuous stream at such a rate that the contents of the flask are maintained at a constant temperature of 130°. Acetic ether and water distil over into the receiver and are purified by the method given above.



Properties.—Colourless liquid, possessing an agreeable smell; b. p. 77° ; sp. gr. $\cdot 9068$ at 15° ; soluble in about 11 parts water, miscible in all proportions with spirit of wine, ether, and acetic acid.

PREPARATION LXI.

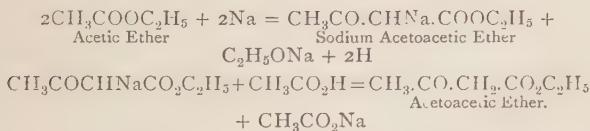


LITERATURE.—Geuther (1863), Jahresb. 323; Frankland, Duppa (1865), Phil. Trans. 156, 37; Wislicenus (1877), Ann. Ch. Pharm. 186, 161.

200 grms. acetic ether.
20 ,, sodium.

Two hundred grms. acetic ether, carefully dehydrated over calcium chloride, are introduced into a dry flask of about $\frac{1}{2}$ litre capacity connected with a long and well cooled condenser. 20 grams. well pressed sodium cut into thin pieces are quickly added and the flask cooled. A violent reaction sets in and the liquid boils. When the first action is over and no further evolution of heat occurs, the mixture is heated on the water-bath with a condenser until the sodium is completely dissolved. The excess of acetic ether is now distilled off in the water-bath and to the warm

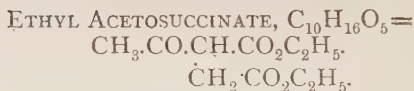
residual liquid 100 grms. 50 per cent. acetic acid is added and the whole well shaken. On cooling 100 grms. water are added and the mixture again well stirred. The liquid divides into two layers; the upper one, consisting of acetoacetic ether, is drawn off and the aqueous layer is extracted with ether, from which, on evaporating off the ether, a further quantity of acetoacetic ether may be obtained. The united portions are washed with a small quantity of water, the aqueous layer separated and the product fractionated in 5 fractions (100–130°, 130–135°, 165–175°, 175–185°, 185–200°). The fraction distilling at 175–185° is nearly pure acetoacetic ether. The brown residue remaining in the distilling flask solidifies on cooling to a crystalline mass consisting chiefly of dehydracetic acid, $C_8H_8O_4$. It is converted into the sodium salt by boiling with soda solution with the addition of animal charcoal and the latter crystallised. On adding dilute sulphuric acid the free acid is obtained nearly pure (colourless needles; m. p. 109°; b. p. 279.6°.)



Properties.—Colourless liquid possessing a fruity odour; b. p. 182°; sp. gr. 1.03 at 5°; very slightly

soluble in water. Ferric chloride gives a violet coloration. Boiled with caustic soda solution the ether splits up into alcohol, carbon dioxide, acetone, and, in smaller quantity, acetic acid.

PREPARATION LXII.

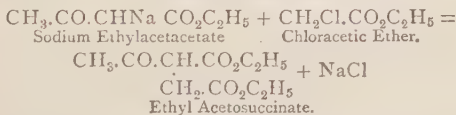


LITERATURE.—Conrad (1877), *Ann. Ch. Pharm.* 183, 215; Rach (1886), *Ann. Ch. Pharm.* 234, 36.

- 52 grms. ethyl acetacetate.
- 9.2 „ sodium.
- 150 „ absolute alcohol.
- 125 „ ethyl monochloracetate.

9.2 grms. metallic sodium in thin slices are dissolved in 150 grms., absolute alcohol contained in a round-bottom flask connected with a reflux condenser. When the first reaction is over, any undissolved sodium may be brought into solution by heating for a short time on the water-bath. 52 grms. ethyl acetacetate are gradually added to the cold alcoholic

solution of sodium ethylate, the mixture being kept cool. The liquid changes to a faint amber colour. The calculated quantity (125 grms.) of ethyl monochloracetate is now slowly introduced, the flask being cooled in water if much heat is developed. The reaction is completed by heating for two hours on the water-bath. The liquid becomes gradually muddy from the separation of sodium chloride and assumes a brown tint. If the reaction is finished a sample of the product diluted with water should no longer have an alkaline reaction. After distilling off the alcohol the residual dark-coloured product is diluted with water and the oily liquid which settles down (ethyl acetosuccinate) is separated, dried over previously heated potassium carbonate and then distilled, whereby the chief portion passes over at $250-260^{\circ}$ and is nearly pure ethyl acetosuccinate. It usually has a faint yellow colour.



Properties.—Colourless liquid; b. p. $254-256^{\circ}$; sp. gr. 1.079 at 21° ; insoluble in water; soluble in alcohol.

PREPARATION LXIII.

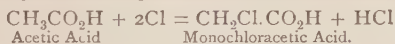
MONOCHLORACETIC ACID, $C_2H_3O_2Cl = CH_2Cl \cdot CO_2H$.

LITERATURE.—R. Hofmann (1857), *Ann. Ch. Pharm.* **102**, 1; H. Müller (1865), *Chem. Soc. J.* **17**, 398.

250 grms. glacial acetic acid.

Two hundred and fifty grms. commercial glacial acetic acid are gently boiled (in a retort of about $\frac{1}{2}$ litre capacity provided with a reflux condenser) over wire gauze and chlorine, dried through sulphuric acid, is passed into the hot liquid.* The operation must be conducted in such a way that the chlorine comes in contact as much as possible with the vapours of the boiling acid. This is effected by fixing the chlorine inlet tube just below the surface of the liquid. At the upper end of the condenser quantities of unabsorbed chlorine and hydrochloric acid gas escape. The retort is placed in direct sunlight, the action proceeding more or less quickly according to the strength of the sun's rays. In direct sunlight the greater part of the acetic acid is converted into the monochlorinated compound in 6—8 hours. The action slackens as the formation of the chloracetic acid proceeds. The yellow product is distilled with the thermometer in the liquid; the portion distilling below 130° consists chiefly of unchanged acetic acid and may be used for a fresh operation, that boiling at 130 — 190° contains

nearly the whole of the monochloracetic acid, the portion which boils above 190° consists of higher chlorinated products (di- and trichloracetic acid). The fraction boiling at $130-190^{\circ}$ quickly solidifies on cooling. The colourless crystalline plates are separated from the mother liquor by pressing them well at the filter pump and are dried *in vacuo* over sulphuric acid and caustic potash. On redistilling the monochloracetic acid, thus purified, it passes over at $184-188^{\circ}$.



Properties.—Rhombic plates or prisms; m. p. 63° ; b. p. $185-187^{\circ}$; easily soluble in water.

PREPARATION LXIV.



(*Amidoacetic Acid.*)

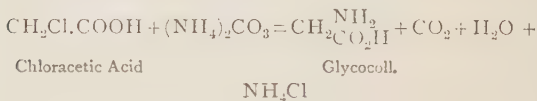
LITERATURE.—Braconnot (1820), Ann. Ch. Phys. (2) 13, 114; Dessaignes (1846), Ann. Ch. Phys. (3) 17, 50; Strecker (1848), Ann. Ch. Pharm. 65, 130; Perkin, Duppa (1859), Chem. Soc. J. 11, 22; Nencki (1883), Ber. 16, 2827.

50 grms. monochloracetic acid.

150 „ ammonium carbonate (commercial).

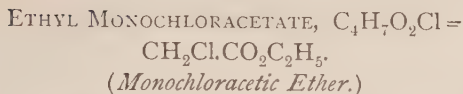
Fifty grms. monochloracetic acid are well mixed with 150 grms. dry powdered commercial ammonium carbonate, and the mixture slowly heated in an open

flask (1 litre capacity) on the oil-bath. At 60—70° the action begins, the mass melts and froths up with strong evolution of carbon dioxide. As the temperature slowly rises to 130° the evolution of gas slackens, and the contents of the flask, which have a faint brown tint, become semi-solid, from the separation of ammonium chloride. The lamp is now removed, the cooled mass dissolved in water and the aqueous solution boiled with lead oxide until the smell of ammonia is no longer perceptible. From the warm filtered solution lead is precipitated with sulphuretted hydrogen and the filtrate is now heated with copper carbonate. The deep blue liquid filtered from excess of carbonate is concentrated. On cooling, the characteristic blue crystals of the copper salt of glycocoll separate out. These are filtered, drained, redissolved in water, and the copper precipitated with sulphuretted hydrogen. The clear solution, evaporated on the water-bath, yields colourless crystals of free glycocoll.



Properties.—Large monoclinic crystals, are discoloured at 228° and melt at $232-236^{\circ}$; scarcely soluble in alcohol and ether, readily soluble in water (1 part glycocoll in 4 parts water). The aqueous solution gives a deep red colour with ferric chloride.

PREPARATION LXV.



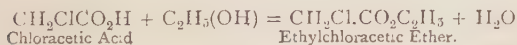
LITERATURE.—Willm (1857), Ann. Ch. Phys. (3) 49, 97; Conrad (1877), Ann. Ch. Pharm. 188, 218.

200 grms. monochloracetic acid.

120 „ absolute alcohol.

25 „ conc. sulphuric acid.

A mixture of 200 grms. monochloracetic acid, 120 grms. absolute alcohol, and 25 grms. conc. sulphuric acid, is heated for about six hours on the water-bath in a round-bottomed flask, of about $\frac{1}{2}$ litre capacity, connected with a reflux condenser. On the addition of water to the product of the reaction, previously allowed to cool, the ether separates out. The ethereal layer is removed, dehydrated over calcium chloride, and distilled. The portion passing over at $138-145^\circ$, is collected, and after fractionation boils constantly at $143-144^\circ$.



Properties.—Colourless liquid, possessing an ethereal odour; b. p. 143.5° ; sp. gr. 1.1585 at 20° .

PREPARATION LXVI.



LITERATURE.—Conrad (1880), *Ann. Ch. Pharm.* **204**, 126; Venable (1880), *Ber.* **13**, 1651; Claisen, Crismer (1883), *Ann. Ch. Pharm.* **218**, 131.

100 grms. monochloracetic acid.

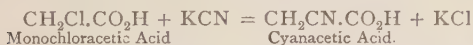
200 „ water.

75 „ potassium carbonate.

75 „ potassium cyanide.

One hundred grms. monochloracetic acid are dissolved in 200 grms. water in a porcelain basin, and the solution neutralised with 75 grms. potassium carbonate.* Seventy-five grms. powdered potassium cyanide are now added, and the mixture heated on the sand-bath until the reaction sets in with strong ebullition. When the reaction is over, the contents of the basin are evaporated as rapidly as possible on the sand-bath, with constant stirring, until a thermometer inserted into the brown semi-fluid mass indicates a temperature of 135° . The mass is allowed to cool without interrupting the stirring and, when cold, the hard saline deposit, consisting of potassium

chloride and potassium cyanacetate is finely powdered and introduced into a round-bottomed flask connected with a condenser. Two-thirds the weight of absolute alcohol is added and the mixture, heated on the water-bath, is saturated with dry hydrochloric acid gas.* The gas is conducted in through a funnel or wide adapter to prevent the inlet tube becoming choked with the crystalline precipitate which is formed. When hydrochloric acid has been passed in for about ten hours, the contents of the flask are cooled, poured into ice water and shaken with 300 c.c. commercial ether, in which the ethyl malonate dissolves. The ethereal layer is then separated from the acid liquid and washed with water and potassium carbonate solution, drawn off, dehydrated over calcium chloride and distilled. When the ether has been driven off, the greater portion of the residue distils at 190—200°. After one or two fractionations the ether is found to boil at 195—196° and is pure.



Monochloroacetic Acid

Cyanacetic Acid.



Diethyl Malonate.

Properties.—Colourless liquid; b. p. 195°; sp. gr. 1.068 at 18°; insoluble in water.

PREPARATION LXVII.



LITERATURE.—Wislicenus, Urech (1873), *Ann. Ch. Pharm.* 165, 93; Tupolew (1874), *Ann. Ch. Pharm.* 171, 243; Markownikow, *Ann. Ch. Pharm.* 182, 329; Conrad (1880), *Ann. Ch. Pharm.* 204, 134.

16 grms. ethyl malonate
 25 „ absolute alcohol.
 2.3 „ sodium.
 20 „ ethyl iodide.

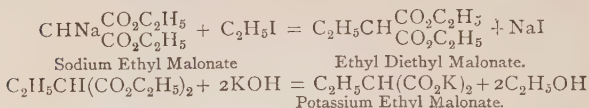
Sodium ethylate is first prepared by dissolving 2.3 grms. sodium in 25 grms. absolute alcohol, and the reaction completed, if necessary, on the water-bath as described on p. 132. Whilst the product is still slightly warm, 16 grms. malonic ether are added from a tap funnel. The liquid remains clear at first, but before the ether has all been added a white crystalline body (sodium ethyl malonate) separates out, and soon the whole solidifies. To the solid mass 20 grms. ethyl iodide are slowly added. The mass softens, and after continued shaking completely liquefies with evolution of heat. The product is now heated on the water-bath, when it becomes turbid from the separation of sodium iodide in the form of a fine powder.

After $1\frac{1}{2}$ hours the liquid ceases to be alkaline, and the reaction is complete. The alcohol is distilled off on a brine-bath. On the addition of water an almost colourless oil separates out. The oil is separated by extraction with ether dehydrated over calcium chloride and distilled. When the ether has been driven off, almost the whole of the residue (ethyl diethyl-malonate) passes over at $206-208^{\circ}$.

Properties.—Colourless liquid, with an agreeable fruity smell; b. p. 207° , sp. gr. 1.008 at 18° .

To obtain the free acid, the ether is saponified with caustic potash. To 25 grms. caustic potash in strong aqueous solution the ether is slowly added from a tap funnel. At first an emulsion forms, which soon solidifies to a white mass. This is heated on the water-bath with constant shaking for about three quarters of an hour, until it becomes completely liquid. The saponification is then complete. The product is diluted with water, neutralised with hydrochloric acid, and the free acid precipitated with calcium chloride as the calcium salt. This is separated from the solution by filtration and concentrated hydrochloric acid added. From the acid solution the free ethylmalonic acid is extracted by shaking with ether. After evaporating off the ether, the acid remains behind as a syrup, which solidifies when cold. This is redissolved in water, boiled with a little animal charcoal to free it from any adhering colouring matter,

filtered and evaporated to syrupy consistency on the water-bath. The colourless acid crystallises on cooling.



Properties.—Rhombic prisms; m. p. 111.5° , easily soluble in water, alcohol and ether; decomposes completely at 160° into carbon dioxide and butyric acid.

PREPARATION LXVIII.

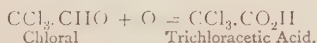
TRICHLORACETIC ACID, $\text{C}_2\text{HCl}_3\text{O}_2 = \text{CCl}_3\text{CO}_2\text{H}$.

LITERATURE.—Dumas (1838), *Compt. rend.* 8, 609; Kolbe (1844), *Ann. Ch. Pharm.* 49, 341 and (1845) *Ann. Ch. Pharm.* 54, 183; Judson (1870), *Chem. Soc. J.* 24, 232; Clermont (1871), *Compt. rend.* 73, 113; (1872) 74, 1492; (1874) 76, 774.

35 grms. chloral hydrate.
100 „ fuming nitric acid, sp. gr. 1.5

In a flask of 500 c.c. capacity, 35 grms. commercial chloral-hydrate are heated to melting, and 100 grms. fuming nitric acid are added to the melted mass.* The mixture is heated carefully over a small flame until the reaction sets in. After a few minutes red fumes

are evolved; the reaction proceeds without the application of heat, and is complete when, on warming the liquid, nitrous fumes cease to come off. The product is now distilled; below 123° excess of nitric acid distils; between 123° and 194° a mixture of trichloroacetic acid and a small quantity of nitric acid pass over, and at 194 — 196° nearly pure trichloroacetic acid collects in the receiver and solidifies on cooling. The fraction boiling at 123 — 190° is treated with a fresh quantity of fuming nitric acid, and the product purified as above.



Properties.—Colourless, rhombohedral crystals; m. p. 55° ; b. p. 195° .

PREPARATION LXIX.

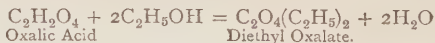


LITERATURE.—Frankland, Duppa; Fittig (1886), *Grundr. der Org. Chem.* 253.

210 grms. anhydrous oxalic acid.

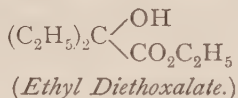
140 „ absolute alcohol.

A mixture of 210 grms. oxalic acid dehydrated at 100° and 140 grms. absolute alcohol is slowly heated to 100° in a flask of about $\frac{3}{4}$ litre capacity connected with a condenser and receiver. The vapour of 140 grms. of a further quantity of absolute alcohol contained in a second flask is passed into the bottom of first flask, in a continuous, but not too rapid stream, the temperature of the contents of the latter being gradually raised to $125-130^{\circ}$. The liquid, which distils, consists of water, alcohol, and a small quantity of oxalic ether, and may be used for the preparation of oxamide. The latter on the addition of conc. aqueous ammonia is precipitated in the form of a white crystalline powder, $C_2O_2(NH_2)_2$. The contents of the flask are now distilled, and the colourless liquid which passes over at $182-186^{\circ}$ collected in a separate vessel.



Properties.—Colourless liquid; b. p. 186° ; sp. gr. 1.103 at 0° ; easily soluble in alcohol and ether; not miscible with water.

PREPARATION LXX.

ETHYL DIETHYL-OXYACETATE, $C_8H_{16}O_3 =$ 

LITERATURE.—Frankland, Duppa (1865), Proc. Roy. Soc. 12, 396; 14, 17; Geuther, Wackenroder (1867), Zeitscher. f. Ch. N. F. 3, 709; Fittig, Howe (1880), Ann. Ch. Pharm. 200, 21.

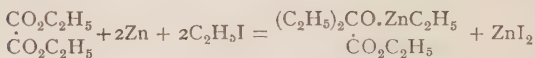
50 grms. ethyl oxalate.

107 „ ethyl iodide.

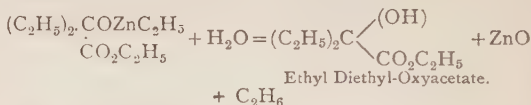
granulated zinc.

Fifty grms. oxalic ether are mixed with 107 grms. ethyl iodide in a round-bottomed flask of $\frac{1}{2}$ litre capacity, and so much granulated zinc (dried at 100° , and slightly amalgamated by dipping it into a weak solution of corrosive sublimate) added, that it remains just covered by liquid. The mixture is heated with reflux condenser on the water-bath for 12—15 hours to $50\text{--}60^\circ$, when the liquid, which at the beginning is clear and of a light yellow colour solidifies to a yellowish-brown semi-crystalline mass. If water be now added to the product until its volume is three times that of the crystalline mass, a strong evolution of gas (ethane) occurs, and the ethyl ether separates out as an oil together with the

unattacked ethyl iodide and is distilled (in a copper vessel) with steam. The distillate is purified by fractional distillation. When the ethyl iodide and alcohol have distilled, the thermometer rises rapidly to 165° , and the portion passing over between 165° and 180° is collected separately. By repeatedly distilling this fraction the ethereal salt of diethyl oxalic acid is obtained pure.



Ethyl Oxalate.



Properties.—Colourless liquid; b. p. 175° : sp. gr. $\cdot 9896$ at $16\cdot 5^{\circ}$.

PREPARATION LXXI.

FORMIC ACID, $\text{CH}_2\text{O}_2 = \text{H} \cdot \text{CO}_2\text{H}$.

LITERATURE.—Berthelot (1856), Ann. Ch. Phys. (3) 46, 477; Lorin (1866), Bull. soc. chim. (2) 5, 7; (1870) (2) 24, 367.

150 grms. anhydrous glycerin.

150 „ oxalic acid.

One hundred and fifty grms. commercial crystallised oxalic acid and 150 grms. glycerin dehydrated at

175° are heated in a retort of $\frac{3}{4}$ -litre capacity with condenser and receiver, on the water- or brine-bath. The reaction begins at 75°, and at 90° proceeds briskly; carbonic anhydride is evolved and aqueous formic acid distils. When the temperature has been maintained for some time at 90–105° and the evolution of carbonic anhydride has nearly ceased, the contents of the retort are cooled to about 80°, and a further 150 grms. crystallised oxalic acid added. The reaction recommences with the formation of aqueous formic acid, which, however, becomes more concentrated with each fresh addition of oxalic acid until the distillate contains 56 per cent. of the acid. In order to regain the formic acid, which remains as monoformin in the retort, the contents are diluted with about 1 litre water and distilled in a current of steam until the distillate has only a faintly acid reaction. On neutralising the united acid distillates by boiling with excess of lead carbonate and concentrating the filtered solution, the lead salt of formic acid is obtained in long colourless prisms, which decompose with sulphuretted hydrogen yielding the anhydrous acid. The powdered salt well dried at 100–110° is introduced in a long layer into the inner tube of a condenser loosely stopped at the lower end by a plug of glass wool, or asbestos.* To the end of the condenser a receiver is attached, which is guarded from moisture by a drying tube. The salt is heated

by passing steam into the outer tube of the condenser. Sulphuretted hydrogen washed through water and

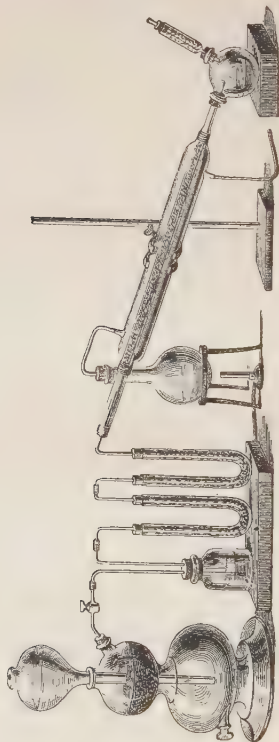
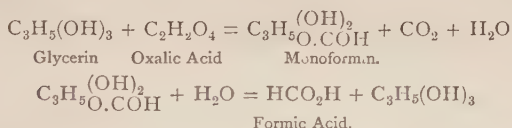


FIG. 30.

then dried by passing over calcium chloride is led over the salt in not too rapid a stream. The arrange-

ment of the apparatus is shown in Fig. 30. The lead formate blackens, and is slowly converted into lead sulphide and formic acid, which flows down into the receiver. The acid, which retains a strong smell of sulphuretted hydrogen, dissolved in the acid is freed from the latter by a second distillation over dry lead formate.



Properties.—Colourless liquid with a penetrating smell; b. p. 99° ; sp. gr. 1.223 at 0° ; solidifies below 0° to colourless crystals; m. p. 8.6° ; soluble in water and alcohol; decomposes on heating with silver and mercury salts, the metals being deposited.

PREPARATION LXXII.

ALLYL ALCOHOL, $\text{C}_3\text{H}_6\text{O} = \text{CH}_2 : \text{CH}.\text{CH}_2\text{OH}$

LITERATURE.—Cahours, Hofmann (1857), Ann. Ch. Pharm. 102, 285; Tollens, Henninger (1870), Ann. Ch. Pharm. 156, 129.

50 grms. oxalic acid.
 200 „ glycerin.
 $\frac{1}{4}$ „ ammonium chloride.

A mixture of 50 grms. commercial powdered oxalic acid, 200 grms. commercial glycerin, and $\frac{1}{4}$ gm. salammoniac, are heated in a retort of about $\frac{1}{2}$ litre capacity over wire gauze with a Bunsen lamp.* Strong evolution of carbonic acid gas at first occurs, and the temperature, indicated by a thermometer inserted into the retort, remains for some time stationary at about 130° . As the temperature slowly rises, the evolution of gas slackens, and after a time (at about 180°) entirely ceases. When the temperature has reached 195° the receiver, which now contains aqueous formic acid, is changed. At $200-210^{\circ}$ carbonic acid is again given off, and oily streaks are observed to run down the neck of the retort; at the same time a disagreeable penetrating smell is perceptible. By gently heating the contents of the retort, a temperature of $220-230^{\circ}$ is maintained for some time, and when it has finally risen to 260° the distillation is stopped. The distillate is a mixture of allyl alcohol and water, and there is also present allyl formate, glycerin, and acrolein. Excess of glycerin remains behind in the retort, and may be used again by repeating the operation with a smaller quantity of oxalic acid (30—40 grms.) until the residue is too small or has become dark-coloured and thick. The whole of the allyl alcohol, together with a small quantity of formic acid, and acrolein, is obtained by submitting the distillate to a second distillation. The distillation

is this time continued until on treating the last portions with potassium carbonate no oily layer (usually of a faint yellow colour) separates. This occurs at about 105° . On adding solid potassium carbonate to the distillate, the allyl alcohol settles out as an oil. This is drawn off, and 5—10 per cent. powdered caustic potash added. After having been allowed to stand for twenty-four hours and well shaken or gently warmed for a short time, the liquid loses the smell of acrolein and at the same time assumes a brown colour. In order to abstract the last traces of water, which are obstinately retained, the allyl alcohol is left in contact with anhydrous baryta and then distilled.



Properties. — Colourless liquid with a pungent odour; b. p. 96° ; sp. gr. 0.858 at 0° .

PREPARATION LXXIII.

ALLYL IODIDE, $\text{C}_3\text{H}_5\text{I} = \text{CH}_2 : \text{CH}.\text{CH}_2\text{I}$.

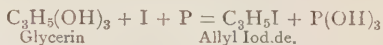
LITERATURE.—Berthelot, de Luca (1855), Ann. Ch. Phys. (3) 43, 257; Tollens, Henninger (1870), Ann. Ch. Pharm. 156, 156; Saytzev, Kanonikoff (1877), Ann. Ch. Pharm. 185, 191; Wagner (1876), Ber. 9, 1810.

100 grms. anhydrous glycerin.

70 „ iodine.

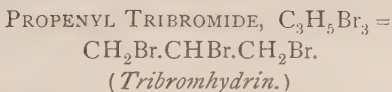
23 „ yellow phosphorus.

Through a mixture of 100 grms. glycerin dehydrated at 175° , and 70 grms. dry powdered iodine, contained in a retort of about $\frac{1}{2}$ -litre capacity and connected with condenser and receiver, a slow current of dry carbonic acid is passed.* 23 grms. yellow phosphorus cut into pieces about the size of a pea and dried between filter-paper are gradually added. The action is assisted at first by gently warming the retort with a small flame. A rather violent reaction then sets in, which is maintained by the addition of more phosphorus, and must be so regulated that the allyl iodide distils as it is produced; otherwise isopropyl iodide is formed. The distillate divides into two layers, and is coloured by dissolved iodine, which has been carried over. The lower layer is washed with dilute caustic soda solution and with water, and is separated from the aqueous portion by a tap-funnel. After dehydrating the liquid over calcium chloride it is distilled. The portion passing over at 98 — 102° is nearly pure allyl iodide and may be used for further experiments.



Properties.—Colourless liquid with an alliaceous odour; b. p. 101 — 102° ; sp. gr. 1.789 at 16° .

PREPARATION LXXIV.



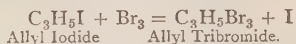
LITERATURE.—Berthelot (1856), Ann. Ch. Phys. (3) 46, 304; Wurtz (1857), Ann. Ch. Phys. (3) 51, 91; Henry (1870), Compt. rend. 70, 638; Tollens (1870), Ann. Ch. Pharm. 156, 168.

50 grms. allyl iodide.

75 „ bromine.

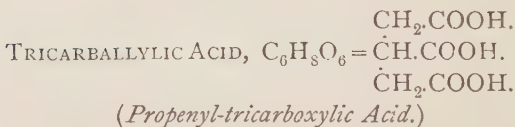
Seventy-five grms. bromine are slowly added in small portions at a time to 50 grms. allyl iodide contained in a flask, which is connected with an air condenser and well cooled in a freezing mixture.* The liquid is then allowed to stand twenty-four hours and separated by filtration from the iodine, which has meanwhile crystallised out. The brown filtrate is repeatedly washed with dilute caustic soda solution and then with water. The allyl bromide is separated from the aqueous portion, dehydrated over fused calcium chloride and distilled. The colour of the liquid on boiling changes to a dark brown and iodine vapours are given off abundantly. The distillate is again treated with caustic soda and water, &c., and redistilled. The temperature, indicated by the thermometer, rises rapidly to 180° and the greater portion of the liquid

distils at 200—220°. This fraction crystallises on standing for a time in a freezing mixture and the crystals are separated from the mother liquor by decantation. The product is purified by repeated distillations.



Properties.—Colourless glistening prisms; m. p. 16°, b. p. 219—220°.

PREPARATION LXXV.



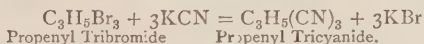
LITERATURE.—Simpson (1865), Proc. Roy. Soc. 14, 77.

50 grms. propenyl tribromide.

36 „ potassium cyanide.

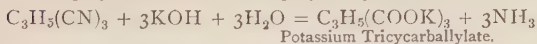
Fifty grms. allyl bromide are dissolved in excess of alcohol and 36 grms. coarsely powdered potassium cyanide added. The whole is then heated in a soda-water bottle with the cork well tied down for 15 hours in the water-bath. The bottle is well cooled and carefully opened and the alcoholic liquid filtered from the potassium bromide, which has separated out. The filtrate is now heated with reflux condenser on the

water-bath with a sufficient quantity of caustic potash (40 grms.) to decompose the cyanide formed, until the evolution of ammonia gas has ceased. The alcohol is distilled off on the brine-bath and an excess of nitric acid added to the cooled residue. On evaporating the mass on the water-bath a residue consisting of potassium nitrate and free tricarballic acid remain from which, after being well dried and powdered, the latter may be extracted with absolute alcohol. On evaporating off the alcohol, the acid remains as a dark-coloured substance and is purified by recrystallisation from water with the addition of animal charcoal.



Propenyl Tribromide

Propenyl Tricyanide.



Potassium Tricarballic.

Properties.—Colourless rhombic plates; m. p. 158° ; easily soluble in water and alcohol.

PREPARATION LXXVI.

GLYCERIC ACID, $\text{C}_3\text{H}_6\text{O}_4 = \text{CH}_2(\text{OH}).\text{CH}(\text{OH}).\text{CO}_2\text{H}$
(*Dioxypropionic Acid.*)

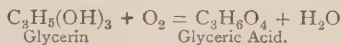
LITERATURE.—Debus (1858), Ann. Ch. Pharm. 106, 79; Sokolow (1858), Ann. Ch. Pharm. 106, 95; Beilstein (1861), Ann. Ch. Pharm. 120, 226; Mulder (1876), Ber. 9, 1902.

50 grms. glycerin.

50 „ fuming nitric acid, sp. gr. 1.5.

Fifty grms. glycerin diluted with an equal volume of water are introduced into a tall narrow glass cylinder. 50 grms. fuming nitric acid sp. gr. 1.5 are carefully run in below the surface of the glycerin by means of a funnel (the neck of which is drawn out into a fine tube) so that two layers are formed. The cylinder is left at the ordinary temperature for some little time until the two layers have diffused and formed a homogeneous liquid. The contents of several such cylinders are slowly evaporated on the water-bath to a syrupy consistence. The residue is diluted with about 2 litres of water and the aqueous solution of glyceric acid neutralised with lead carbonate and a small quantity of lead oxide. Towards the end of the operation the liquid is heated to boiling and filtered whilst hot. On concentrating and cooling the aqueous solution, the impure lead salt of glyceric acid is obtained, which may be purified by recrystallisation. The salt which crystallises out in crusts on the sides of the vessel to which it firmly adheres, may be detached by warming. By concentrating the mother liquors a further quantity of crystals slowly separates out. The finely powdered salt is mixed into a paste with water and decomposed in portions of 25 grms. with sulphuretted hydrogen.

The aqueous solution, filtered from lead sulphide, is evaporated on the water-bath, when the acid remains in the form of a thick syrup.



Properties.—Strongly acid syrup of a faint yellow colour, which does not crystallise; soluble in water and alcohol, insoluble in ether.

PREPARATION LXXVII.

β -IODPROPIONIC ACID, $\text{C}_3\text{H}_5\text{IO}_2 = \text{CH}_2\text{I}.\text{CH}_2.\text{COOH}$.

LITERATURE.—Beilstein (1861), Ann. Ch. Pharm. 120, 230 and (1862) 127, 366; Moldenhauer (1864), Ann. Ch. Pharm. 131, 323; Kekulé (1864), Ann. Ch. Pharm. 131, 223; Mulder (1876), Ber. 9, 1902; Wislicenus (1873), Ann. Ch. Pharm. 166, 1; Erlenmeyer (1878), Ann. Ch. Pharm. 191, 284.

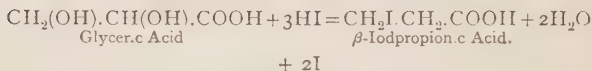
52 c.c. glyceric acid sp. gr. 1.26.

100 grms. phosphorus diiodide.

One hundred grms. phosphorus diiodide¹ are added in small quantities to 52 c.c. glyceric acid sp. gr. 1.26 contained in a large round-bottomed flask and in order

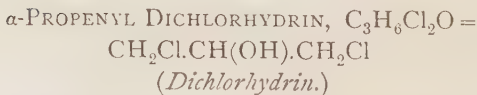
¹ *Preparation of Phosphorus Diiodide* (Fittig (1886), *Grundriss der Org. Chem.*).—Forty-one parts dry powdered iodine are added to a well-cooled solution of 5 parts phosphorus dissolved in carbon bisulphide. The carbon bisulphide is then distilled off.

to start the process the mixture is gently heated. A violent reaction sets in with the formation of a dark brown syrupy liquid. If the reaction proceeds too violently the flask is cooled in water. The product is again heated, when a second less violent reaction occurs and a light yellow liquid is produced, which on cooling solidifies to a crystalline mass. From this, iodopropionic acid may be extracted with hot carbon bisulphide or petroleum ether. On distilling off the solvent a discoloured residue remains, from which the acid may be obtained in colourless crystals by recrystallisation from carbon bisulphide.



Properties.—Colourless pearly laminae; m. p. 83.5° ; slightly soluble in cold, readily in hot water and in alcohol.

PREPARATION LXXVIII.

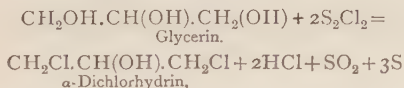


LITERATURE.—Berthelot (1854) Ann. Ch. Phys. (3) 41, 296; Reboul (1860), Ann. Ch. Phys. (3) 60, 1; Carius (1862), Ann. Ch. Pharm. 122, 73; Claus (1873), Ann. Ch. Pharm. 168, 42.

100 grms. anhydrous glycerin.

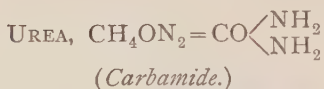
250 „ chloride of sulphur. (See p. 114.)

Two hundred and fifty grms. chloride of sulphur are slowly added in small quantities from a tap funnel to 100 grms. anhydrous glycerin (dehydrated at 175°) contained in a retort, which is connected with a reflux condenser.* During the process the contents of the retort are well shaken. The reaction is completed on the brine-bath until the evolution of hydrochloric acid has nearly ceased. The condenser is now removed, and the mass again heated until all sulphur dioxide and hydrochloric acid are expelled. The product of the reaction which becomes semi-solid on cooling is extracted with 2-3 times the volume of ether. The ethereal solution is filtered from sulphur and the ether distilled. A liquid remains which may be purified by repeated rectification.



Properties.—Colourless liquid with an ethereal smell ;
b. p. 175·8—176·3° ; sp. gr. 1·383 at 0°.

PREPARATION LXXIX.



LITERATURE.—Wöhler (1828), Pogg. Ann. 12, 253, Berz. Jahresb. 12, 226; Clemm (1848), Ann. Ch. Pharm. 66, 382.

100 grms. anhydrous potassium ferrocyanide.¹

37.5 „ „ potassium carbonate.

187 „ „ red oxide of lead.

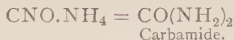
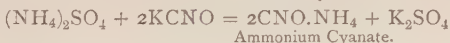
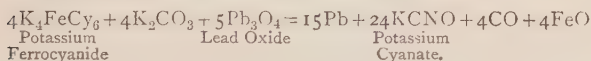
100 „ „ neutral ammonium sulphate.²

One hundred grms. carefully dehydrated potassium ferrocyanide and 37.5 grms. anhydrous potassium carbonate are well mixed, and the mixture heated in a covered iron crucible, in a charcoal furnace, until it fuses quietly without the application of too strong a heat. To the cooled, but still liquid mass 300 grms. dry red oxide of lead are gradually added in small quantities, and the whole again fused for a time. When the reduced lead has collected at the bottom of the vessel, the liquid mass is poured off on to an iron plate and allowed to cool. It solidifies and is broken up. It is then dissolved in about 200 c.c.

¹ *Potassium ferrocyanide* ($\text{K}_4\text{FeCy}_6 + 3\text{H}_2\text{O}$) is dehydrated by heating the powdered salt on an iron tray over a small flame with constant stirring.

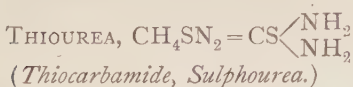
² *Commercial ammonium sulphate* has usually a slightly acid reaction, and must therefore be neutralised with ammonia.

water, the aqueous solution of potassium cyanate filtered, and a concentrated solution of 100 grms. neutral ammonium sulphate added to the filtrate. The liquid is evaporated to a small bulk on the water-bath, and on cooling, the crystallised potassium sulphate separated from the mother liquor. The filtrate is evaporated to dryness, and the cooled residue extracted with absolute alcohol, which dissolves out the urea. On distilling off the alcohol, the solid greenish residue is purified by recrystallisation from alcohol with the addition of animal charcoal.



Properties.—Colourless prisms; m. p. 131° , easily soluble in water, scarcely soluble in ether.

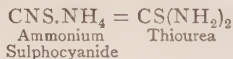
PREPARATION LXXX.



LITERATURE.—Reynolds (1869), Chem. Soc. J. 22, 1; Volhard (1874), Journ. prakt. Ch. (2) 9, 10; Claus (1875), An. Ch. Pharm. 179, 113.

50 grms. ammonium sulphocyanide.

Fifty grms. dry ammonium sulphocyanide are melted (at about 160°) in a round-bottomed flask on the oil-bath, and kept at a temperature at which the mass remains just liquid (140 — 145°) for 5—6 hours. The cooled melt is powdered and ground with two-thirds its weight of cold water, which dissolves unchanged ammonium sulphocyanide, and but little of the thiourea. By dissolving the residue, which has usually a somewhat reddish tint, in hot water, pure sulphourea is obtained on cooling in colourless crystals.



Properties.—Colourless rhombic prisms (from dilute aqueous solution), long silky needles (from concentrated solutions), m. p. 175° . Very slightly soluble in cold water (one part thiourea dissolves in about eleven parts water at the ordinary temperature).

PREPARATION LXXXI.



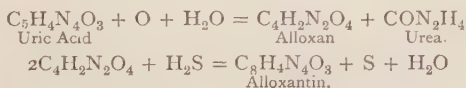
LITERATURE.—Liebig, Wöhler (1838), Ann. Ch. Pharm. 26, 262.

10 grms. uric acid.

20 „ hydrochloric acid (sp. gr. 1.19 diluted with an equal quantity of water).

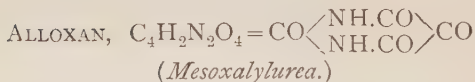
2 $\frac{1}{2}$ „ potassium chlorate.

Twenty grms. hydrochloric acid are poured over 10 grms. powdered uric acid, and to the mixture previously heated to 35° , $2\frac{1}{2}$ grms. finely powdered potassium chlorate are slowly added in small quantities at a time with constant stirring. When about four-fifths of the chlorate has been added, the uric acid has nearly dissolved, and the liquor has a faint yellow colour. It is diluted with double the volume of water, allowed to stand for about one hour and filtered. The filtrate is saturated with sulphuretted hydrogen, and yields, after being left for 12 hours, crystalline crusts, often of a reddish tint, of alloxantin mixed with sulphur. It is filtered and washed with cold water, and the alloxantin dissolved in a small quantity of hot water and filtered off from the residue of sulphur. On cooling the filtrate, colourless crystals separate out.



Properties. — Hard colourless crystals, scarcely soluble in cold, more readily in hot water; gives with baryta water a characteristic violet precipitate.

PREPARATION LXXXII.



LITERATURE.—Liebig, Wöhler (1838), Ann. Ch. Pharm. 26, 256; Liebig (1868), Ann. Ch. Pharm. 147, 366; E. Fischer (1882), Ann. Ch. Pharm. 215, 310.

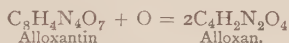
10 grms. alloxantin.

10 „ conc. nitric acid (sp. gr. 1.42).

20 „ fuming nitric acid (sp. gr. 1.5).

Ten grms. finely powdered alloxantin are added to a mixture of 20 grms. fuming nitric acid (sp. gr. 1.5), and 10 grms. conc. nitric acid (sp. gr. 1.42), and allowed to stand. Slight evolution of nitrous fumes occurs, and the alloxantin, which at first remains at the bottom of the vessel, slowly changes into the more bulky crystals of alloxan, which gradually fill the liquid. The reaction lasts about two days, and is complete when a sample dissolves readily and completely in cold water. The crystalline mass is spread upon a porous plate, thoroughly dried in the air, and freed from traces of nitric acid by heating in a basin on the water-bath until the smell of the acid disappears. Alloxan may be obtained in large

crystals by dissolving the dry product in the smallest quantity of hot water and allowing the solution to evaporate slowly.



Properties.—Colourless brilliant crystals, containing four molecules of water of crystallisation, very soluble in water.

APPENDIX.

APPENDIX.

NOTES ON THE PREPARATIONS.

PART I.

PURIFICATION OF ALCOHOL.

Boiling-point Determination.—A standard thermometer, *i.e.* one that has been calibrated and the 0° and 100° points carefully determined, may be had from a scientific-instrument maker. An ordinary thermometer, corrected by a standard thermometer at Kew, will serve equally well. Where the boiling-points of small quantities of liquid have to be determined small vessels must necessarily be used. Short thermometers are made for such purposes, so that the neck of a small distilling-flask may inclose the thread of mercury. For high boiling liquids similar short thermometers, registering from 100° upwards, are made. The correction for barometric pressure is 0.43° for every 1 mm. below 760 (Landolt).

PURIFICATION OF ETHER.

Iodoform Reaction.—On heating iodine in presence of caustic potash and certain organic bodies, a characteristic crystalline

yellow substance, iodoform (CHI_3), is formed. This reaction may be used for ascertaining the presence of small quantities of *ethyl alcohol* (in water orether), *acetone* (in wood-spirit or acetic acid), *aldehyde*, &c. It appears that all bodies containing the group $\text{CH}_3\text{CO.C-}$ or $\text{CH}_3\text{CH(OH)C-}$, or yielding such groups in presence of iodine and potash, give this reaction (Lieben).

PURIFICATION OF BENZENE.

The treatment with conc. sulphuric acid dissolves out small quantities of thiophen, and dissolves and polymerises the olefines usually present in crude coal-tar benzene. Bromine acts more quickly on the paraffins than on benzene. Rapid decolorisation therefore indicates the presence of the former.

PREPARATION I.

Monobromobenzene.—A general property of organic compounds is that one or more atoms of hydrogen are replaceable by a halogen. When the action of Cl. Br. or I. on a hydrocarbon is one of substitution the hydrogen is eliminated in combination with the halogen as hydracid and the halogen takes its place. The reaction proceeds at the ordinary temperature, more quickly at a high temperature and in direct sun-light. In case of the homologues of benzene, *e.g.* toluene, the difference of temperature determines whether the hydrogen is replaced in the benzene nucleus or in the side-chain. At a low temperature or in presence of iodine or other substance which acts as a carrier of Cl, *i.e.* readily takes up Cl and parts with it again (SbCl_3 , MoCl_3), the substitution is in the nucleus; at a high temperature the hydrogen is replaced in the side-chain (Prep. XX.). The halogen substitution products of the aromatic group are much more stable, *i.e.* less readily acted on by reagents than those of the fatty series.

PREPARATION II.

Ethyl Benzene.—"Fittig's reaction," so called from its discoverer, is analogous to the synthetical method employed in the preparation of the fatty hydrocarbons (Wurtz). It is generally applicable, and a long series of homologues of benzene have been prepared in this way.

PREPARATION III.

Nitrobenzene.—The formation of nitro-compounds by the action of strong nitric acid is a distinctive property of aromatic compounds. It appears, indeed, that the smaller the relative proportion of C to H in a compound the more readily does it form nitro-substitution products. The number of hydrogen atoms replaceable by the nitroxyl-group (NO_2) is limited; but also depends on the quantity and dilution of the acid and the temperature of nitration. The oxidising action of the *dilute* acid on the side-chain is exemplified in Prep. XL. This is analogous to the action of nitric acid in the fatty series, where both strong and dilute acid have, as a rule, an oxidising action (Preps. LXVIII. and LXXVI.). Nitro-compounds have often a yellow or red colour, are difficultly or not at all volatile, and possess a much higher boiling-point than the corresponding halogen substitution products.

PREPARATION IV.

Aniline.—Fatty and aromatic nitro-compounds are readily reducible with any of the ordinary reducing agents (ammonium sulphide, iron and acetic or hydrochloric acid, zinc and sulphuric, hydriodic acid, &c.). The oxygen of the nitro-group is replaced by hydrogen, and an amido-compound thereby formed. The latter has basic properties, much less marked, however, than the fatty

amines, which more closely resemble ammonia. Thus aniline hydrochloride has an acid reaction. The action of alkaline reducing agents, such as sodium alcoholate on aromatic nitro-compounds, to form azoxy- and azo-compounds, should be noted. Hofmann's reaction may be expressed equationally as follows :—

$$\text{C}_6\text{H}_5\text{NH}_2 + \text{CHCl}_3 + 3\text{KOH} = \text{C}_6\text{H}_5\text{NC} + 3\text{KCl} + 3\text{H}_2\text{O}.$$

PREPARATION V.

Acetanilide.—Amido-compounds are readily acted on by glacial acetic acid or acetic anhydride and form acetyl derivatives or acid-amides (Prep. LVIII.). They are stable bodies, distilling without decomposition. Heated with conc. hydrochloric acid or caustic soda they split up into their components. With chlorine, bromine, nitric acid, &c., substitution products are formed.

PREPARATION VI.

Nitracetanilide.—The aromatic amido-compounds cannot be directly nitrated without undergoing decomposition. With the acetyl derivative or salt of the base, where the amido-group is protected by combination with an acid or acid radical, the operation is readily performed. Observe that the "nitroxyl" takes up by preference the ortho- and para-positions to the "amido" group.

PREPARATION VII.

Dinitrobenzene.—By further nitrating benzene with stronger acid, and at a higher temperature, a second "nitroxyl" is introduced. This latter takes up the meta-position to the first. Note the same relative positions of the nitroxyl groups in picric acid (Prep. XVI.). Whereas a second nitroxyl is readily introduced into the aromatic nucleus, the substitution of a third H atom becomes a matter of greater difficulty.

PREPARATION VIII.

Nitraniline.—Ammonium sulphide is selected here as the reducing agent, on the ground that the action is slow, and may be interrupted after one nitroxyl group has been reduced.

PREPARATION IX.

Diethylaniline.—The tertiary aromatic bases, although analogous in composition to the tertiary amines of the fatty group, have, like the primary bases, less basic properties (Prep. IV.), due probably to the negative character of the radical "phenyl" (Ber. 20, 534). The formation of the "nitrosamine" compound described in the footnote to this preparation is characteristic of all secondary amines or imido-compounds. The "nitrosyl" group (NO) takes the place of the hydrogen atom in the imido-group, = NH, to form nitrosamine, = N.NO.

PREPARATION X.

Nitrosodimethylaniline.—The action of nitrous acid on tertiary amines occurs in the case of aromatic compounds only.

PREPARATION XI.

p-Nitrosophenol.—This compound is also formed by the action of nitrous acid on phenol. Liebermann's reaction is only applicable to aromatic "nitroso" compounds or "nitrosamines" of the fatty series.

PREPARATION XII.

Potassium Benzene Sulphonate.—The action of conc. sulphuric acid on aromatic hydrocarbons is analogous to that of conc. nitric acid. One or more hydrogen atoms of the benzene nucleus are replaceable by the sulphoxyl group (SO_3H) and water is

eliminated. The substitution of a second and third H atom becomes a more difficult operation, and the action is brought about by the use of the fuming acid containing a large percentage of SO_3 or in conjunction with P_2O_5 . The free sulphonic acid may be obtained by precipitating the lead salt with H_2S , or the barium salt with sulphuric acid and evaporating the filtrate.

PREPARATION XIII.

Phenol.—The replacement of the sulfoxyl group by hydroxyl by fusion with caustic potash is generally applicable to the preparation of this class of bodies (naphthol from naphthalene sulphonic acid, oxyquinoline from quinoline sulphonic acid, &c.). The action of the two alkalis (NaOH , KOH) is not identical. Whereas with potash molecular change may occur, *i.e.* the hydroxyl does not necessarily take the place of the sulfoxyl group (resorcinol is formed from *o*-benzene disulphonic acid), this is not so often observed with caustic soda. The latter has, however, a greater oxidising action, so that, for example, by fusing resorcinol $\text{C}_6\text{H}_4(\text{OH})_2$ with caustic soda phloroglucinol $\text{C}_6\text{H}_3(\text{OH})_3$ is formed (Barth, Schreder). The phenols are also formed from halogen substitution products of benzene by fusion with caustic potash. Compare the latter reaction with that of the fatty compounds.

PREPARATION XIV.

Anisol.—A characteristic property of the hydroxyl group (OH) is that the hydrogen is replaceable by alcohol or acid radicals, forming acid and alcohol ethers. This is true of alcohols (Prep. XLIV.), phenols, and acids (Prep. XLII. and LVII.). The phenol ethers are split up into phenol and chloride or iodide of the alcohol radical by heating with HCl or HI to a high temperature (in sealed tubes), $\text{C}_6\text{H}_5\text{OCH}_3 + \text{HI} = \text{CH}_3\text{I} +$

C_6H_5OH . This reaction has been made the basis of a quantitative method for determining the number of methoxyl-groups ($-OCH_3$) present in a compound.

PREPARATION XV.

O- and *p*-Nitrophenol.—Compare the action of nitric acid on benzene.

PREPARATION XVI.

Picric Acid.—The strongly negative or acid character of the H in the hydroxyl group is due to the presence of the three nitroxyl groups. (Compare the di- and trinitro-derivatives of the paraffins.) Picric acid behaves like an organic acid in decomposing the alkaline carbonates to form salts. In this respect it differs from non-substituted phenols, which combine only with the caustic alkalis.

PREPARATION XVII.

Phenolphthalein.—The action of conc. sulphuric acid is that of a dehydrating agent; that is to say, it withdraws the elements of water from the reacting substances. The reaction, which occurs in this way between organic compounds, resulting in the formation of more complicated bodies, in which the carbon atoms form the connecting link, is termed “condensation.” The condensation products produced by similar dehydrating agents ($ZnCl_2$, anhydrous oxalic acid, $SnCl_4$, $NaOH$, &c.) form a large chapter in organic chemistry.

PREPARATION XX.

Benzyl Chloride.—The chlorination of the toluene is conducted at a high temperature, and takes place therefore in the side chain. By continued action the whole of the three hydrogen

atoms of the methyl group may be replaced by chlorine. At the ordinary temperature, or in presence of a little iodine, the substitution occurs in the benzene nucleus.

PREPARATION XXI.

Benzaldehyde.—In addition to the reactions cited at the end of the preparation, the compounds, which benzaldehyde forms with HCN and hydroxylamine are characteristic alike of all aldehydes and ketones. In the former case compounds of the general

formula $R^1C \begin{matrix} \nearrow OH \\ \searrow CN \end{matrix}$ are produced, which may be readily converted

into an oxy-acid containing a carbon atom more than the original compound (Prep. XXIII.). In the latter reaction the hydroxylamine combines (water being eliminated) to form a compound of the general formula $=C:N.OH$. In the case of aldehyde the compound thus formed has received the name of *aldoxime* (aldehyde-oximido) in that of certain ketones *acetoxime* (acetone-oximido), and similarly *glyoxime* and *quinoxime* (Prep. XI.). A further property of the “carbonyl” group (CO), common to aldehydes and ketones, is that the oxygen atom by the action of PCl_5 is replaceable by two atoms of chlorine. Benzaldehyde yields benzylene chloride, $C_6H_5CHCl_2$. Aldehydes readily form condensation products (Prep. XXXVI.).

PREPARATION XXII.

Benzyl Alcohol.—The action of caustic potash on aldehydes to form alcohol and acid is not equally applicable to fatty aldehydes. In the latter case, especially with the lower members of the series, resinous products are formed.

PREPARATION XXIII.

α-Toluic Acid.—The property of nitrils to yield an acid with the same number of C atoms, by the action of mineral acids or

alkalis, is common to fatty and aromatic compounds (Preps. XLVIII., LXVI.).

PREPARATION XXIV.

Oxybenzaldehyde.—"Reimer's reaction" for the preparation of oxyaldehydes from phenols is applicable to a very large number of monhydric and polyhydric phenols. The substitution of two H atoms by two aldehyde groups sometimes occurs as in the case of resorcinol. An analogous reaction is that of potash and carbon tetrachloride on phenol with the formation of oxybenzoic acid.

PREPARATION XXV.

Acetophenone.—The production of ketones by the dry distillation of certain organic salts (Ca or Ba salts) occurs also in the case of fatty acids. If a formate be one of the salts employed, an aldehyde is obtained thus: $\text{H.COOM}^1 + \text{C}_6\text{H}_5\text{COOM}^1 = \text{C}_6\text{H}_5\text{COH} + \text{M}_2^1\text{CO}_3$.

PREPARATION XXVI.

Benzoin.—This preparation affords an interesting example of molecular change and polymerisation produced by the action of potassium cyanide. Furfurol, $\text{C}_4\text{H}_3\text{O.CO.H}$, forms, under like conditions, a similar compound (furoin). The reducing action of benzoin on Fehling's solution is shared by aldehydes and hydrazines, and also those bodies (the sugars) which, like benzoin, contain the ketone alcohol group, $\text{CO.CH}_2(\text{OH})$.

PREPARATION XXVIII.

Benzoyl Chloride.—The substitution of hydroxyl (OH) by Cl, by the action of PCl_3 or PCl_5 , applies to all classes of organic compounds, and the fact is therefore made use of in ascertaining the presence of this group.

PREPARATION XXXI.

Benzonitril.—"Letts' reaction" yields in the case of fatty acids mainly the acid amides. Among the numerous other methods by which the nitrils are formed may be mentioned the action of dehydrating agents (P_2O_5 , P_2S_5) on the acid amides. By the action of reducing agents on nitrils (Zn and H_2SO_4 and Na on an alcoholic solution of the nitril) the amines are formed. $C_6H_5CN + H_4 = C_6H_5CH_2NH_2$. Benzonitril yields benzylamine. With hydroxylamine the *amidoximes* are obtained, $C_6H_5CN + NH_3O = C_6H_5(NH_2):NOH$.

PREPARATION XXXII.

Diazobenzene Nitrate.—This reaction, discovered by Griess, is applicable to all amido-compounds of the aromatic series. By using it as an intermediate step, it is possible to substitute hydrogen, the halogens, hydroxyl, cyanogen, and hydrothionyl (SH) for the amido-group. It is not, however, always necessary or advisable to isolate the diazo-compound; but to submit the compound in solution to the further action of reagents. The free base, $C_6H_5N:N.OH$, has not yet been obtained pure. Compare the action of nitrous acid on the primary fatty amines.

PREPARATION XXXIII.

Diazoamidobenzene.—This class of compounds may be regarded as intermediate products in the formation of the azoamido-compounds, and are only formed in the case of primary amines. In other cases (action of diazobenzene on phenols in alkaline solution or tertiary bases in faintly acid solution) the azo-compound is directly produced.

PREPARATION XXXIV.

Amidoazobenzene.—This reaction is an interesting example of molecular change induced by the presence of a small quantity of aniline hydrochloride. It appears, however, that the latter actually takes part in the reaction, replacing the group C_6H_5NH in the diazoamido-compound and regenerating a further quantity of the hydrochloride (Ber. 10, 664 and 1156). It should be noted that the N atom of the diazo-compound replaces by preference the hydrogen of the base which is in the para-position to the amido-group. Amidoazobenzene may be considered as the lowest of the series of that large class of colouring matters known as the azo-colours. They consist essentially of aromatic nuclei double-linked by nitrogen atoms, $R-N:N-R$ and $R-N:N-R-N:N-R$ (tetrazo-compounds). Where the hydrogen atoms of the nuclei (benzene and homologues, naphthalene, &c.) are replaced by the amido-group only, basic colouring matters are formed (aniline yellow, chrysoidine); if by sulphonyl or hydroxyl in addition or alone (and these form the larger class) acid colouring matters are produced. The colours produced in this way are mainly yellow, red, and intermediate shades. By increasing the size of the molecule (tetrazo-compounds) violet and blue shades have been obtained; but as yet no green colour.

PREPARATION XXXV.

Phenylhydrazine.—The action of reducing agents on diazobenzene was first observed by E. Fischer. In addition to $SnCl_2$ other reducing agents ($NaHSO_3$, zinc dust and acetic acid) may be used. The action of phenylhydrazine on the carbonyl group (CO) yields a compound of the general formula $=C:N_2HC_6H_5$.

PREPARATION XXXVI.

Cinnamic Acid.—"Perkin's reaction," so-called from its discoverer, is applicable to substituted aromatic aldehydes, on the one hand, and a large number of fatty acids on the other. According to Fittig the reaction proceeds in the following manner, in which the *aldol* condensation first occurs between the acid and the aldehyde, the acetic anhydride acting as dehydrating agent, $C_6H_5COH + CH_3.CO_2Na = C_6H_5CH(OH).CH_2.CO_2Na = C_6H_5CH : CH.CO_2Na + H_2O$. This reaction furnishes a good illustration of condensation.

PREPARATION XXXVII.

Hydrocinnamic Acid.—Note that the use of sodium amalgam in aqueous or alcoholic solution as a reducing agent is widely applicable.

PREPARATION XXXVIII.

Quinoline.—"Skraup's reaction" may be employed in the case of homologues of aniline, also naphthylamine or anthramine. In this way a large number of quinoline derivatives have been prepared. The first stage of the reaction consists probably in the formation of an aldehyde (acrolein) by the dehydrating action of conc. sulphuric acid on glycerin. The formation of quinaldine (methyl-quinoline) from aldehyde and aniline appears to point to this.

PREPARATION XXXIX.

Mesitylene.—This reaction is an example of *condensation* produced by the action of conc. sulphuric acid, and at the same time of the synthetical formation of an aromatic from a fatty compound. Similar condensations occur in the case of non-saturated hydrocarbons (allylene) and mixed ketones (methylethyl ketone yields triethylbenzene).

PREPARATION XL.

Mesitylenic and Uvic Acid.—The oxidation of the side-chains in aromatic hydrocarbons is a matter of considerable interest, as illustrating the difference of stability of the side-chain and nucleus, and also of the influence which the relative positions of the side-chains exert in presence of oxidising agents. In the first place it may be mentioned that the aromatic nucleus is acted on by the ordinary oxidising agents only with difficulty. The result is usually complete destruction of the nucleus and the formation of carbonic and oxalic acids. On the other hand, side-chains may be partially or completely oxidised to carboxyl (CO_2H) by choosing suitable oxidising agents. The reagents usually employed are chromic acid or potassium dichromate and sulphuric acid, dilute nitric acid and potassium permanganate in acid or alkaline solution. The action of these on the side-chain, when more than one side-chain is present, depends upon their relative position. Thus, for example, chromic acid or potassium dichromate and sulphuric acid completely destroys the compound when the side-chains occupy the ortho-position (Fittig), whereas the para- and meta-compounds yield the corresponding carboxylic acids. This is true also of substituted hydrocarbons with one side-chain, thus meta- and para-nitrotoluol give meta- and para-nitrobenzoic acid. The ortho-compound with the same oxidising agent is completely oxidised. Dilute nitric acid, or potassium permanganate in alkaline solution, may be used in the oxidation of ortho-side-chains; also, on account of their less energetic action, for partial oxidation where only one side-chain is to be converted into carboxyl.

PREPARATION XLI.

Triphenylmethane.—"Friedel and Craft's reaction," thus named from its discoverers, is very widely applicable, not

only in the preparation of aromatic hydrocarbons ; but also in the formations of ketones, &c., by the action of Al_2Cl_6 on the hydrocarbon in presence of COCl_2 , thus : $2\text{C}_6\text{H}_6 + \text{COCl}_2 = (\text{C}_6\text{H}_5)_2\text{CO} + 2\text{HCl}$.

PREPARATION XLII.

Ethyl Benzoate.—This reaction for the preparation of ethereal salts is generally applicable. The mode in which the reaction proceeds is a disputed point. According to Friedel the acid chloride is first formed and reacts upon the alcohol. According to Henry's views, the reaction takes place in several steps as follows : $\text{R}'\text{COOH} + \text{C}_2\text{H}_5\text{OH} = \text{R}'\text{C}(\text{OH})_2\text{OC}_2\text{H}_5$; $\text{R}'\text{C}(\text{OH})_2\text{OC}_2\text{H}_5 + \text{HCl} = \text{R}'\text{C}(\text{OH})\text{ClOC}_2\text{H}_5 + \text{H}_2\text{O}$; $\text{R}'\text{C}(\text{OH})\text{ClOC}_2\text{H}_5 = \text{R}'\text{COOC}_2\text{H}_5 + \text{HCl}$. Another general method for preparing ethereal salts is to act on the dry powdered silver salt of the acid with the alcohol iodide (Wurtz).

PART II.

PREPARATION XLIII.

Ethyl Bromide.—The replacement of the hydrogen by halogen in fatty hydrocarbons occurs under like conditions to those of the aromatic series, *i.e.* by the direct action of the halogen. A simpler method, however, is to replace the alcohol *hydroxyl* by halogen by the action of the hydric acid (HCl , HBr , HI) or by

that of the phosphorus compound (PCl_3 , PBr_3 , P_3). It is not requisite to prepare the latter previous to the operation. As in the preparation of ethyl bromide, the bromide of phosphorus is formed in the presence of alcohol and is at once decomposed. The alcohol may be regenerated from the bromide by heating with water alone or with water and PbO in sealed tubes. With ammonia under similar conditions the fatty amines are produced (Hofmann). With caustic alkalis a hydrocarbon of the series C_nH_{2n} is formed.

PREPARATION XLIV.

Ethyl Ether.—This class of bodies are the oxides of the alcohol radicals. They are also formed by the action of sodium alcoholate upon the alcoholic iodides (Williamson). In this way mixed ethers, *i.e.* ethers with dissimilar alcohol radicals, may be readily obtained. The ethers are inert bodies from the fact that the whole of the hydrogen present is united to carbon atoms. Note the action of sodium on alcohol and on ether. The ethers are decomposed with PCl_5 into the haloid ethers of the two alcohol radicals. Hydracids, especially HI , have a similar action. The acid ethers or ethereal salts (German “ester”) are much less stable, and are readily hydrolysed, *i.e.* decomposed with caustic alkali into alcohol and acid (Prep. XLII.).

PREPARATION XLVI.

Ethyl Orthoformate.—The formation of this compound is analogous to that of the ethers by Williamson's method, *i.e.* by the action of sodium alcoholate upon the iodide of the alcohol radical thus: $\text{C}_2\text{H}_5\text{ONa} + \text{C}_2\text{H}_5\text{I} = \text{C}_2\text{H}_5\text{OC}_2\text{H}_5 + \text{NaI}$.

PREPARATION XLVII.

Potassium Ethyl Sulphate.—Compare the action of sulphuric acid on alcohol with that of sulphuric acid on phenol (Prep. XVI.).

PREPARATIONS XLVIII. AND XLIX.

Propionitril.—Read what is written on Prep. XXIII. and XXXI.

PREPARATION L.

Ethylene Bromide.—Hydrocarbon groups with double or treble-linked C atoms, whether occurring free (olefines, acetylenes) or forming part of a compound (Prep. XXXVI.), combine directly with the halogens (most readily with bromine) without evolution of gas, also with the hydracids (to form halogen compounds) nascent hydrogen (to form saturated hydrocarbons) and hypochlorous acid (to form oxyhalogen compounds). Caustic alkalis decompose ethylene bromide, removing first one atom of bromine and one atom of hydrogen from the adjoining carbon atom, and, by prolonged action of the alkali, a second atom of carbon and a second atom of hydrogen and acetylene is formed, $C_2H_4Br_2 + KOH = C_2H_3Br + KBr + H_2O$; $C_2H_3Br + KOH = C_2H_2 + KBr + H_2O$.

PREPARATION LI.

Ethylene Glycol.—The behaviour of dihydric alcohols or glycols towards reagents is similar to that of the monhydric alcohols. It is possible to act upon and modify one or both of the carbinol groups. In the first case a compound would be obtained, which, whilst retaining the character of an alcohol, would

also possess in part the properties of a compound formed by a similar action on a monhydric alcohol. Thus from glycol it is possible to derive glycollic acid, $\text{CH}_2(\text{OH}).\text{COOH}$, a body possessing the properties of both alcohol and acid. It should be remembered that the isomeric glycol with both hydroxyls attached to one carbon atom has not been isolated. Where such a body might be expected to be formed the elements of water are eliminated and aldehyde produced.

PREPARATION LII.

Ethylene Chlorhydrin.— S_2Cl_2 acts on the hydroxyl in a similar manner to, but less energetically than, PCl_5 , and at the same time more powerfully than HCl .

PREPARATION LIII.

Succinic Acid.—Read Prep. XXIII.

PREPARATION LIV.

Dibromsuccinic Acid.—Whereas the replacement of hydrogen by chlorine usually occurs under ordinary conditions of temperature, the substitution of bromine (having a less affinity for hydrogen) often requires a high temperature and pressure, and the process is therefore carried out in sealed tubes. The water present, by absorbing some of the hydrobromic acid as it is formed, prevents too great an increase of pressure. The presence of bromine and water together may, under certain circumstances, have an oxidising action. In such cases bromine must be used alone.

PREPARATION LV.

Acetaldehyde.—Read what is written on Prep. XXI. Note also the action of ammonia on benzaldehyde and acetaldehyde.

PREPARATION LVI.

Acetyl Chloride.—Read what is written on Prep. XXVIII. Acetyl chloride determines the presence of the hydroxyl group in alcohols and phenols. By their mutual action hydrochloric acid is evolved and the hydrogen of the hydroxyl replaced by *acetyl*, $C_2H_5OH + C_2H_3OCl = C_2H_5O.C_2H_3O + HCl$.

PREPARATION LVII.

Acetic Anhydride.—This class of compounds may be regarded as oxides of acid radicals, just as ether is the oxide of the alcohol radical. Anhydrides may also be prepared by the action of $POCl_3$ on the potassium salt of the acid in presence of excess of the latter.

PREPARATION LVIII.

Acetamide.—Refer to the preparation of benzamide, Prep. XXVIII.

PREPARATION LIX.

Methylamine Hydrochloride.—This compound belongs to the class of fatty organic bases or amines, *i.e.* bodies having basic properties analogous to ammonia, combining therefore with acids to form salts. By replacing one atom of hydrogen in ammonia by an alcohol radical the primary amines are produced by the replacement, in the same way of two atoms of hydrogen the secondary amines see Prep. XI., of three atoms of hydrogen, the tertiary amines. The latter have the property of combining with alcohol iodide to form substituted ammonium iodides. Trimethylamine, $(CH_3)_3N$, yields tetramethylammonium iodide, $(CH_3)_3N.CH_3I$. The action of nitrous acid differentiates the three classes of amines. In the primary amines the amido-group is replaced by hydroxyl (see Prep. XXXII.).

The secondary group form "nitrosamines" (see Prep. IX.); on the tertiary amines nitrous acid has no action (see Prep. X.). Hofmann's reaction for primary amines is applicable to the fatty compounds (Prep. IV.).

PREPARATION LX.

Ethyl Acetate.—Refer to the preparation of ethyl benzoate (Prep. XLII.).

PREPARATION LXI.

Ethyl Acetoacetate.—A similar reaction occurs also with mixed ethereal salts (Ber. 19, 3225, and 20, 589).

PREPARATION LXIII.

Monochloroacetic Acid.—The substitution of hydrogen by chlorine is analogous to that of the hydrocarbons. In the homologous fatty acids, as in the present case, the Cl atom replaces the H atom of the C adjoining the carboxyl group.

PREPARATION LXIV.

Glycocoll.—The amido-acids are neutral bodies; but combine with bases, acids, and salts. Nitrous acid has the same action on the amido-group as on the primary amines, forming oxyacids (Prep. LIX., notes). The hydrochloride of glycocoll ether dissolved in water and treated with NaNO_2 yields the diazo-acid ether. This is a general reaction for amido-acids of the fatty series (Ber. 17, 959).

PREPARATION LXVI.

Diethyl Malonate.—Read what is written on Prep. XXIII.

PREPARATION LXVII.

Ethylmalonic Acid.—In those compounds in which the group $\text{CO.CH}_2\text{.CO}$ occurs (Prep. LXI.), both H atoms are successively replaceable by Na. If ethylmalonic ether were acted on by a second atom of sodium and a second molecule of alcohol iodide both H atoms would be replaced by alcohol radicals. It is possible in this way to build up a series of homologous dibasic acids. Note that dibasic acids with both carboxyl groups attached to the same C atom readily lose CO_2 on heating and form the monobasic acid.

PREPARATION LXX.

Ethyl Diethoxalate.—This reaction of Frankland and Duppa consists, in the first place, in the formation of zinc ethyl (by the action of zinc on ethyl iodide), and this reacting on the acid ether replaces the O atom of the one carbonyl group by two (it can also replace it by one) alcohol radicals. The reaction is applicable to ethers of monobasic acids, but not to the homologues of oxalic ether, $\text{C}_n\text{H}_{2n-2}\text{O}_4$. A similar reaction occurs in the case of aldehydes, ketones, and acid chlorides.

PREPARATIONS LXXI. AND LXXII.

Formic Acid and Allyl Alcohol.—Note the different action of oxalic acid on glycerin at different temperatures. The reducing action of formic acid on mercury and silver salts is due to the aldehyde character of the acid, $(\text{OH}).\text{COH}$.

PREPARATION LXXIII.

Allyl Iodide.—This reaction is due to the action of HI, or, what amounts to the same, the combined action of iodine and phosphorus on glycerin. It is probable that propenyl triiodide is first formed, $\text{CH}_2\text{I.CHI.CH}_2\text{I}$, which decomposes into

$\text{CH}_2 : \text{CH}.\text{CH}_2\text{I} + \text{I}_2$. With an excess of HI allyliodide is further transformed into propylene, $\text{CH}_2 : \text{CH}.\text{CH}_2\text{I} + \text{HI} = \text{CH}_2 : \text{CH}.\text{CH}_3 + \text{HI} + \text{I}_2$, and isopropyl iodide, $\text{CH}_2 : \text{CH}.\text{CH}_3 + \text{HI} = \text{CH}_3.\text{CHI}.\text{CH}_3$.

PREPARATION LXXIV.

Propenyl Tribromide.—The bromine has a two-fold action. It acts in the first place by addition, as in the case of ethylene bromide (Prep. L.), and in the second place by substitution replacing the atom of I.

PREPARATION LXXVI.

Glyceric Acid.—Note the oxidation of the carbinol group $\text{CH}_2(\text{OH})$ to carboxyl (CO_2H) characteristic of primary alcohols.

PREPARATION LXXIX.

Urea.—Further properties of urea are as follows : It decomposes above its melting-point into biuret and cyanuric acid. Boiled with alkalis, or heated gently with conc. sulphuric acid, it takes up the elements of water, giving off NH_3 and CO_2 . It undergoes similar decomposition in putrefying urine. It combines with acids, bases, and salts to form crystallisable compounds. The nitrate and the compound, obtained by adding a solution of mercuric nitrate to urea, are characteristic.

PREPARATION LXXXII.

Alloxan.—The constitution of alloxan has been determined by the following reactions amongst others. It decomposes with caustic soda or potash into mesoxalic acid and urea. It combines with hydroxylamine to form violuric acid (presence of carbonyl group). On further oxidation with dilute nitric acid it loses CO , and yields parabanic acid (oxalyl urea), the constitution of which has been synthetically determined.

I.—TABLE OF THE ATOMIC WEIGHTS OF THE ELEMENTS.

Element.	Symbol.	Atomic Weight.	Element.	Symbol.	Atomic Weight.
Aluminium	Al.	27·04	Molybdenum	Mo.	95·9
Antimony	Sb.	120·29	Nickel	Ni.	58·6
Arsenic.....	As.	74·9	Niobium	Nb.	93·7
Barium.....	Ba.	136·86	Nitrogen	N.	14·01
Beryllium	Be.	9·08	Osmium	Os.	195
Bismuth	Bi.	207·5	Oxygen	O.	15·96
Boron	B.	10·9	Palladium	Pd.	106·2
Bromine	Br.	79·76	Phosphorus.....	P.	30·96
Cadmium.....	Cd.	111·7	Platinum	Pt.	194·43
Caesium	Cs.	132·7	Potassium	K.	39·03
Calcium	Ca.	39·91	Rhodium	Rh.	104·1
Carbon	C.	11·97	Rubidium	Rb.	85·2
Cerium	Ce.	141·2	Ruthenium	Ru.	103·5
Chlorine	Cl.	35·37	Scandium.....	Sc.	44
Chromium	Cr.	52·45	Selenium	Se.	78·87
Cobalt	Co.	58·6	Silicon	Si.	28·33
Copper.....	Cu.	63·18	Silver	Ag.	107·66
Didymium	Di.	145	Sodium.....	Na.	22·99
Erbium	E.	166	Strontium	Sr.	87·3
Fluorine	F.	19·06	Sulphur	S.	31·98
Gallium	G.	69·8	Tantalum	Ta.	182
Germanium.....	Ge.	72·75	Tellurium	Te.	127·7
Gold	Au.	196·85	Terbium	Tb.	148·5
Hydrogen	H.	1	Thallium	Tl.	204
Indium.....	In.	113·4	Thorium	Th.	231·96
Iodine	I.	126·54	Tin	Sn.	117·35
Iridium	Ir.	192·5	Titanium	Ti.	50·25
Iron	Fe.	55·88	Tungsten.....	W.	183·6
Lanthanum.....	La.	138·5	Uranium	U.	239·8
Lead	Pb.	206·39	Vanadium	V.	51·1
Lithium	Li.	7·01	Ytterbium	Yb.	173·2
Magnesium.....	Mg.	23·94	Yttrium	Y.	89·6
Manganese	Mn.	54·8	Zinc	Zn.	64·88
Mercury	Hg.	198	Zirconium	Zr.	90·4

II.—TABLE OF SPECIFIC GRAVITY AND PERCENTAGE OF SULPHURIC ACID IN AQUEOUS SOLUTION. (Kolb.)

Sp. gr. at 15° compared with water at 0° = 1.

Degrees Beaumé	Sp. gr. $d = 15/0.$	100 parts by weight con- tain H_2SO_4 .	Degrees Beaumé	Sp. gr. $d = 15/0.$	100 parts by weight con- tain H_2SO_4 .
1	1'007	1'9	34	1'308	40'2
2	1'014	2'8	35	1'320	41'6
3	1'022	3'8	36	1'332	43
4	1'029	4'8	37	1'345	44'4
5	1'037	5'8	38	1'357	45'6
6	1'045	6'8	39	1'370	46'9
7	1'052	7'8	40	1'383	48'3
8	1'060	8'8	41	1'397	49'8
9	1'067	9'8	42	1'410	51'2
10	1'075	10'8	43	1'424	52'6
11	1'083	11'9	44	1'438	54'0
12	1'091	13	45	1'453	55'4
13	1'100	14'1	46	1'468	56'9
14	1'108	15'2	47	1'483	58'3
15	1'116	16'2	48	1'498	59'6
16	1'125	17'3	49	1'514	61
17	1'134	18'5	50	1'530	62'5
18	1'142	19'6	51	1'540	64
19	1'152	20'8	52	1'563	65'5
20	1'162	22'1	53	1'580	67
21	1'171	23'3	54	1'597	68'6
22	1'180	24'5	55	1'615	70
23	1'190	25'8	56	1'634	71'6
24	1'200	27'1	57	1'652	73'2
25	1'210	28'4	58	1'671	74'7
26	1'220	29'6	59	1'691	76'4
27	1'231	30'9	60	1'711	78'1
28	1'241	32'2	61	1'732	79'9
29	1'252	33'4	62	1'753	81'7
30	1'263	34'7	63	1'774	84'1
31	1'274	36	64	1'796	86'5
32	1'285	37'4	65	1'81	89'7
33	1'297	38'8	66	1'842	100

III.—TABLE OF SPECIFIC GRAVITY AND PERCENTAGE OF H_2SO_4 IN CONCENTRATED SULPHURIC ACID. (Lunge and Naef.)

Sp. gr. at 15° compared with water at $4^\circ = 1$.

Percent. H_2SO_4 .	Sp. gr. $d = 15/4$.	Percent. H_2SO_4 .	Sp. gr. $d = 15/4$.
90	1·8185	96	1·8406
91	1·8241	97	1·8410
92	1·8294	98	1·8412
93	1·8339	99	1·8403
94	1·8372	100	1·8384
95	1·8390		

IV.—TABLE OF SPECIFIC GRAVITY AND PERCENTAGE OF NITRIC ACID IN AQUEOUS SOLUTION. (Kolbe.)

Sp. gr. at 15° compared with water at $0^\circ = 1$.

Sp. gr. at 15° .	Percentage HNO_3 .	Sp. gr. at 15° .	Percentage HNO_3 .	Sp. gr. at 15° .	Percentage HNO_3 .	Sp. gr. at 15° .	Percentage HNO_3 .
1·530	100	1·451	77·6	1·363	58	1·237	37·95
1·529	99·5	1·445	76	1·358	57	1·225	36
1·523	97·9	1·442	75	1·353	56·1	1·218	35
1·516	96	1·438	74	1·346	55	1·211	33·8
1·514	95·2	1·435	73	1·341	54	1·198	32
1·509	94	1·432	72·4	1·339	53·8	1·192	31
1·506	93	1·429	71·2	1·335	53	1·185	30
1·503	92	1·423	69·9	1·331	52·3	1·179	29
1·499	91	1·419	69·2	1·323	51	1·172	28
1·495	90	1·414	68	1·317	49·9	1·166	27
1·494	89·5	1·410	67	1·312	49	1·157	25·7
1·488	88	1·405	66	1·304	48	1·138	23
1·486	87·4	1·400	65	1·298	47·1	1·120	20
1·482	86·1	1·395	64	1·295	46·6	1·105	17·4
1·478	85	1·393	63·6	1·284	45	1·089	15
1·474	84	1·386	62	1·274	43·5	1·077	13
1·470	83	1·381	61·2	1·264	42	1·067	11·4
1·467	82	1·374	60	1·257	41	1·045	7·2
1·463	80·9	1·372	59·6	1·251	40	1·022	4
1·460	80	1·368	58·8	1·244	39	1·010	2
1·456	79						

V.—TABLE OF SPECIFIC GRAVITY AND PERCENTAGE OF HYDROCHLORIC ACID IN AQUEOUS SOLUTION.

Sp. gr. at 15°.	Percentage HCl.	Sp. gr. at 15°.	Percentage HCl.	Sp. gr. at 15°.	Percentage HCl.	Sp. gr. at 15°.	Percentage HCl.
1'007	1'5	1'055	11'0	1'116	23'1	1'175	34'7
1'010	2'2	1'060	12	1'125	24'8	1'180	35'7
1'014	2'9	1'067	13'4	1'134	26'6	1'185	36'8
1'019	3'8	1'075	15	1'143	28'4	1'190	37'9
1'022	4'5	1'083	16'5	1'150	29'7	1'194	38'6
1'029	5'8	1'091	18'1	1'152	30'2	1'199	39'8
1'031	6'2	1'094	18'6	1'159	31'5	1'202	40'5
1'036	7'3	1'100	19'9	1'161	32	1'205	41'2
1'044	8'9	1'105	20'9	1'166	33	1'210	42'4
1'052	10'4	1'108	21'5	1'171	33'9	1'212	43

VI.—TABLE OF SPECIFIC GRAVITY AND PERCENTAGE OF CAUSTIC POTASH IN AQUEOUS SOLUTION.

Sp. gr. at 15°.	Percentage of KOH.	Sp. gr. at 15°.	Percentage of KOH.	Sp. gr. at 15°.	Percentage of KOH.	Sp. gr. at 15°.	Percentage of KOH.
1'009	1	1'166	19	1'374	37	1'590	54
1'017	2	1'177	20	1'387	38	1'604	55
1'025	3	1'188	21	1'400	39	1'618	56
1'033	4	1'198	22	1'412	40	1'630	57
1'041	5	1'209	23	1'425	41	1'642	58
1'049	6	1'220	24	1'438	42	1'655	59
1'058	7	1'230	25	1'450	43	1'667	60
1'065	8	1'241	26	1'462	44	1'681	61
1'074	9	1'252	27	1'475	45	1'695	62
1'083	10	1'264	28	1'488	46	1'705	63
1'092	11	1'276	29	1'499	47	1'718	64
1'101	12	1'288	30	1'511	48	1'729	65
1'110	13	1'300	31	1'525	49	1'740	66
1'119	14	1'311	32	1'539	50	1'754	67
1'128	15	1'324	33	1'552	51	1'768	68
1'137	16	1'336	34	1'565	52	1'780	69
1'146	17	1'349	35	1'578	53	1'790	70
1'155	18	1'361	36				

VII.—TABLE OF SPECIFIC GRAVITY AND PERCENTAGE OF CAUSTIC SODA IN AQUEOUS SOLUTION.

Sp. gr. at 15°.	Percentage of NaOH.	Sp. gr. at 15°.	Percentage of NaOH.	Sp. gr. at 15°.	Percentage of NaOH.	Sp. gr. at 15°.	Percentage of NaOH.
1'012	1	1'213	19	1'405	37	1'580	54
1'023	2	1'225	20	1'415	38	1'591	55
1'035	3	1'236	21	1'426	39	1'601	56
1'048	4	1'247	22	1'437	40	1'611	57
1'058	5	1'258	23	1'447	41	1'622	58
1'070	6	1'269	24	1'457	42	1'633	59
1'081	7	1'279	25	1'468	43	1'643	60
1'092	8	1'290	26	1'478	44	1'654	61
1'103	9	1'300	27	1'488	45	1'666	62
1'115	10	1'310	28	1'499	46	1'674	63
1'126	11	1'321	29	1'509	47	1'684	64
1'137	12	1'332	30	1'519	48	1'695	65
1'148	13	1'343	31	1'529	49	1'705	66
1'159	14	1'353	32	1'540	50	1'715	67
1'170	15	1'363	33	1'550	51	1'726	68
1'181	16	1'374	34	1'560	52	1'737	69
1'192	17	1'384	35	1'570	53	1'748	70
1'202	18	1'395	36				

VIII.—TABLE OF SPECIFIC GRAVITY AND PERCENTAGE OF AMMONIA IN AQUEOUS SOLUTION.

Sp. gr. at 14° compared with water at 14° = 1.

Sp. gr.	Percentage of NH ₃ .	Sp. gr.	Percentage of NH ₃ .	Sp. gr.	Percentage of NH ₃ .	Sp. gr.	Percentage of NH ₃ .
'884	36	'905	27	'931	18	'963	9
'886	35	'907	26	'934	17	'967	8
'888	34	'910	25	'933	16	'970	7
'890	33	'913	24	'941	15	'974	6
'892	32	'916	23	'944	14	'979	5
'895	31	'919	22	'948	13	'983	4
'897	30	'922	21	'952	12	'987	3
'900	29	'925	20	'955	11	'991	2
'902	28	'928	19	'959	10	'995	1

INDEX.

A.

Acetaldehyde, 120
 Acetamide, 127
 Acetanilide, 22
 Acetate of calcium, 62
 Acetic anhydride, 126
 Acetic ether, 130, 131
 Acetmonobromamide, 129, 138
 Acetoacetic ether, 132
 Acetone, 134
 Acetophenone, 62
 Acetosuccinic ether, 134
 Acetyl oxide, 126
 Acetyl chloride, 124
 Acrolein, 152
 Air bath for sealed tubes, 119
 Air condenser, 22
 Alcohol, purification of, 3
 commercial absolute, 3
 ethyl, 3
 Aldehyde ammonia, 122
 Aldehyde, 120
 reaction for, 55
 Alloxan, 165, 166
 Alloxantin, 164
 Allyl alcohol, 151
 Allyl iodide, 153
 Amidoacetic acid, 137
 Amidoazo benzene, 78
 Amidobenzene, 19
 Ammonium acetate, 127
 Aniline, 19
 Aniline black, 49
 Aniline yellow, 78
 Anisol, 41

B.

Benzaldehyde, 53
 Benzanide, 68, 94
 Benzene, 75
 purification of, 7
 50 per cent., 8
 90 per cent., 8
 Benzenesulphonic acid, 37
 Benzenyl chloride, 53
 Benzoate of calcium, 62
 Benzoic ether, 93
 Benzoin, 64
 Benzil, 65
 Benzlic acid, 66
 Benzonitril, 72
 Benzoquinone, 48
 Benzoyl chloride, 67
 Benzylacetic acid, 82
 Benzyl alcohol, 55
 Benzyl cyanide, 57
 Benzyl chloride, 51
 Benzylene chloride, 53
 Bisulphite of soda, 54
 Bitter almond oil, 53
 Boiling point, determination of, 3
 correction for, 4, 25
 Brommaleic acid, 120
 Bromobenzene, 12, 76
 Butyric acid, 144

C.

Calcium acetate, 62
 Calcium benzoate, 62
 Carbamide, 162

Carbolic acid, 39
 Chloracetic acid 136, 144
 Chloral, 104
 Chloride of sulphur, 114
 Chlorine, 125,
 preparation of, 51
 Chloroform, 103
 Cinnamic acid, 81
 Cyanacetate of potassium, 148

D.

Dehydracetic acid, 133
 Diazoamidobenzene, 76
 Diazobenzene nitrate, 73,
 perbromide, 76
 Dibromobenzene, 14
 Dibromsuccinic acid, 118
 Dichlorohydrin, 160
 Diethyl malonate, 140
 Diethyl oxalate, 145
 Diethylaniline, 31
 Dimethylamine, 36
 Dinitrobenzene, 28
 Dioxydiphenylphthalid, 46
 Dioxypropionic acid, 157
 Diphenylglycollic acid, 66
 Diphenylmethane, 91
 Diphenylthiourea, 69
 Distillation, fractional, 8
 in steam, 21
 in vacuo, 91
 dry, 62

E.

Ethane, 147
 Ether, commercial, 5
 methylated, 6
 preparation of, 100
 purification of, 5
 Ethyl acetate, 130, 131
 Ethyl acetoacetate, 132
 Ethyl acetosuccinate, 134
 Ethyl benzene, 15
 Ethyl benzoate 93
 Ethyl bromide, 95
 Ethyl cyanide, 107
 Ethyl Diethoxalate, 147
 Ethyl Diethyl-oxyacetate, 147
 Ethyl monochloracetate, 139

Ethyl orthoformate, 104
 Ethyl oxide, 100
 Ethyl sulphate, 106
 Ethylaniline, 31, 33
 Ethylene, 110
 Ethylene alcohol, 113
 Ethylene chlorhydrate, 114
 Ethylene chlorhydrin, 114
 Ethylene cyanide, 117
 Ethylene dibromide, 110
 Ethylene dicarboxylic acid, 117
 Ethylene glycol, 113
 Ethylmalonic acid, 142
 Ethylmalonic ether, 142
 Ethylphenylnitrosamine, 33

F.

Fittig's reaction, 15
 Fischer's reaction for aldehydes, 55
 Formic acid, 149
 Fractional distillation, 8
 Fractionating apparatus, 9 10
 Friedel and Craft's reaction, 90
 Fusel oil, 4
 Fusion with potash, 39, 66

G.

Glyceric acid, 157
 Glycocol, 137
 Glycol, 113

H.

Heating under pressure, 119
 Hofmann's reaction, 22
 Hydrobenzamide, 55
 Hydrochloric acid, preparation of, 93
 Hydrocinnamic acid, 82
 Hydrolysis, 94, 143
 Hydroquinone, 50

I.

Iodobenzene, 75
 Iodopropionic acid, 159
 Isopropi. nitril, 108
 Isopurpuric acid, 46

K.

Ketone, oxybenzylphenyl, 64
phenylmethyl, 52

L.

Lead formate, 149
Leucaniline, 92
Liebermann's reaction, 36

M.

Malonic ether, 140
Melting point, determination of, 23
 correction for, 25
 Roth's apparatus, 25
Mesoxalylurea, 166
Meta-dinitrobenzene, 28
Methyl alcohol, commercial, 5
Methyl carbimide, 129
Methyl phenate, 41
Methylamine hydrochloride, 128
Methylated ether, 6
Methylated spirit, 4
 purification of, 4
Methylene blue, 35
Mesitylene, 85
Mesitylenic acid, 87
Monobromobenzene, 12
Monochloracetic acid, 136
Monochloracetic ether, 139
Monoethylaniline, 33
Monoformin, 149, 153

N.

Nitracetanilide, ortho- and para-, 26
Nitraniline, ortho- and para-, 28
 meta-, 29
Nitrobenzene, 17
Nitrogen trioxide, preparation of, 74
Nitrophenol, ortho- and para-, 42
Nitrosodimethylaniline, 33
Nitrosophenol, 35
Notes on preparations, Appendix, 171
—191

O.

Orthoformic ether, 104
Oxalic ether, 145
Oxamide, 146
Oxybenzaldehyde, ortho- and para-, 59
Oxybenzene, 39
Oxybenzylphenylketone, 64

P.

Paradioxybenzene, 50
Paraoxyphenol, 50
Perkin's reaction, 81
Phenol, 39, 75
 nitro derivatives of, 42, 45
Phenolphthalein, 46
Phenolsulphonic acid, 45
Phenyl cyanide, 72
Phenyl methyl ether, 41
Phenyl mustard oil, 70
Phenyl sulphocarbimide, 70
Phenylacetamide, 22
Phenylacetic acid, 56
Phenylacrylic acid, 81
Phenylamine, 19
Phenylcarbamine, 22
Phenylhydrazine, 55, 79
Phenylmethylketone, 62
Phenylpropionic acid, 82
Phosphorus diiodide, 159
Phosphorus trichloride, 124
Picric acid, 45
Potassium benzene sulphonate, 37
 cyanacetate, 141
 cyanate, 162
 ethyl sulphate, 106
Propenyl dichlorhydrin, 160
 tribromide, 155
 tricarboxylic acid, 156
 tricyanide, 157
Propionic acid, 109
Propionitril, 107

Q.

Quinhydrone, 49
Quinol, 50
Quinoline, 84
Quinone, 48
Quinonoxime, 35

R.

- Reaction for primary amines, 22
 for nitroso compounds, 36
 for aldehydes, 55
 Reimer's reaction, 59
 Rosaniline hydrochloride, 92

S.

- Salicylaldehyde, 59
 Saponification, 94, 143
 Sealed tubes, 119
 Sodium amalgam, preparation of, 82
 bisulphite, 54
 Specific gravity, determination of, 97
 Spirits of wine, 3, 4
 Succinic acid, 117
 Succinic anhydride, 118
 Sulphocarbamide, 163
 Sulphocarbamilamide, 71
 Sulphocarbamilide, 69
 Sulphourea, 163
 Sulphovinic acid, 106
 Sulphur monochloride, 114
 Sulphuric ether, 100

T.

- Tables of Atomic weights; Appendix
 p. 192
 specific gravity of sulphuric acid;
 Appendix p. 193, 194

- Tables of specific gravity of nitric acid,
 Appendix p. 194
 hydrochloric acid, Appendix p.
 195
 caustic potash solutions Appendix
 p. 195
 caustic soda solutions, Appendix
 p. 196
 ammonia solutions, Appendix
 p. 196

- Thiocarbamilide, 69
 Thiocarbamide, 165
 Thiophen, 7
 Thiourea, 163
 Toluic acid, 56
 Tribromhydrin, 155
 Tribromophenol, 41
 Tricarballic acid, 156
 Trichloracetic acid, 144
 Trimethylbenzene, 85
 Trinitrophenol, 45
 Triphenylguanidine, 71
 Triphenylmethane, 90

U.

- Urea, 162
 Uvic acid, 87

V.

- Vinyl bromide, 113

March, 1887.

A Catalogue
OF
Educational Books

PUBLISHED BY

Macmillan & Co.,

BEDFORD STREET, STRAND, LONDON.

CONTENTS.

CLASSICS—

	PAGE
ELEMENTARY CLASSICS	3
CLASSICAL SERIES	7
CLASSICAL LIBRARY, (1) Text, (2) Translations	11
GRAMMAR, COMPOSITION, AND PHILOLOGY	17
ANTIQUITIES, ANCIENT HISTORY, AND PHILOSOPHY	21

MATHEMATICS—

ARITHMETIC AND MENSURATION	23
ALGEBRA	25
EUCLID, AND ELEMENTARY GEOMETRY	28
TRIGONOMETRY	28
HIGHER MATHEMATICS	29

SCIENCE—

NATURAL PHILOSOPHY	36
ASTRONOMY	41
CHEMISTRY	41
BIOLOGY	43
MEDICINE	47
ANTHROPOLOGY	48
PHYSICAL GEOGRAPHY AND GEOLOGY	49
AGRICULTURE	49
POLITICAL ECONOMY	50
MENTAL AND MORAL PHILOSOPHY	50

HISTORY AND GEOGRAPHY	52
---------------------------------	----

MODERN LANGUAGES AND LITERATURE—

ENGLISH	56
FRENCH	61
GERMAN	64
MODERN GREEK	66
ITALIAN	66

DOMESTIC ECONOMY	66
----------------------------	----

ART AND KINDRED SUBJECTS	67
------------------------------------	----

WORKS ON TEACHING	67
-----------------------------	----

DIVINITY	68
--------------------	----

29 AND 30, BEDFORD STREET, COVENT GARDEN.
LONDON, W.C., *March*, 1887.

CLASSICS.

ELEMENTARY CLASSICS.

18mo, Eighteenpence each.

THIS SERIES FALLS INTO TWO CLASSES—

(1) First Reading Books for Beginners, provided not only with **Introductions and Notes**, but with **Vocabularies**, and in some cases with **Exercises** based upon the Text.

(2) Stepping-stones to the study of particular authors, intended for more advanced students who are beginning to read such authors as Terence, Plato, the Attic Dramatists, and the harder parts of Cicero, Horace, Virgil, and Thucydides.

These are provided with **Introductions and Notes**, but **no Vocabulary**. The Publishers have been led to provide the more strictly Elementary Books with Vocabularies by the representations of many teachers, who hold that beginners do not understand the use of a Dictionary, and of others who, in the case of middle-class schools where the cost of books is a serious consideration, advocate the Vocabulary system on grounds of economy. It is hoped that the two parts of the Series, fitting into one another, may together fulfil all the requirements of Elementary and Preparatory Schools, and the Lower Forms of Public Schools.

The following Elementary Books, with Introductions, Notes, and **Vocabularies**, and in some cases with **Exercises**, are either ready or in preparation:—

Aeschylus.—**PROMETHEUS VINCTUS.** Edited by Rev. H. M. STEPHENSON, M.A.

Cæsar.—**THE GALLIC WAR. BOOK I.** Edited by A. S. WALPOLE, M.A.

THE INVASION OF BRITAIN. Being Selections from Books IV. and V. of the "De Bello Gallico." Adapted for the use of Beginners. With Notes, Vocabulary, and Exercises, by W. WELCH, M.A., and C. G. DUFFIELD, M.A.

THE GALLIC WAR. BOOK I. SELECTIONS. Adapted for the use of Beginners. With Notes, Exercises, and Vocabulary, by W. WELCH, M.A., and C. G. DUFFIELD, M.A.

[*In preparation.*]

THE GALLIC WAR. BOOKS II. AND III. Edited by the Rev. W. G. RUTHERFORD, M.A., LL.D., Head-Master of Westminster School.

THE GALLIC WAR. BOOK IV. Edited by CLEMENT BRYANS, M.A., Assistant-Master at Dulwich College.

THE GALLIC WAR. SCENES FROM BOOKS V. AND VI. Edited by C. COLBECK, M.A., Assistant-Master at Harrow; formerly Fellow of Trinity College, Cambridge.

THE GALLIC WAR. BOOKS V. AND VI. (separately). By the same Editor. Book V. *ready.* Book VI. *in preparation.*

THE GALLIC WAR. BOOK VII. Edited by JOHN BOND, M.A., and A. S. WALPOLE, M.A.

[*In preparation.*]

Cicero.—**DE SENECTUTE.** Edited by E. S. SHUCKBURGH, M.A., late Fellow of Emmanuel College, Cambridge.

DE AMICITIA. By the same Editor.

STORIES OF ROMAN HISTORY. Adapted for the Use of Beginners. With Notes, Vocabulary, and Exercises, by the Rev. G. E. JEANS, M.A., Fellow of Hertford College, Oxford, and A. V. JONES, M.A., Assistant-Masters at Haileybury College.

Eutropius.—Adapted for the Use of Beginners. With Notes, Vocabulary, and Exercises, by WILLIAM WELCH, M.A., and C. G. DUFFIELD, M.A., Assistant-Masters at Surrey County School, Cranleigh.

Homer.—**ILIAD. BOOK I.** Edited by Rev. JOHN BOND, M.A., and A. S. WALPOLE, M.A.

ILIAD. BOOK XVIII. THE ARMS OF ACHILLES. Edited by S. R. JAMES, M.A., Assistant-Master at Eton College.

ODYSSEY. BOOK I. Edited by Rev. JOHN BOND, M.A. and A. S. WALPOLE, M.A.

Horace.—ODES. BOOKS I.—IV. Edited by T. E. PAGE, M.A., late Fellow of St. John's College, Cambridge; Assistant-Master at the Charterhouse. Each 1s. 6d.

Livy.—BOOK I. Edited by H. M. STEPHENSON, M.A., Head Master of St. Peter's School, York.

THE HANNIBALIAN WAR. Being part of the XXI. AND XXII. BOOKS OF LIVY, adapted for the use of beginners, by G. C. MACAULAY, M.A., Assistant-Master at Rugby; formerly Fellow of Trinity College, Cambridge.

THE SIEGE OF SYRACUSE. Being part of the XXIV. AND XXV. BOOKS OF LIVY, adapted for the use of beginners. With Notes, Vocabulary, and Exercises, by GEORGE RICHARDS, M.A., and A. S. WALPOLE, M.A.

Lucian.—EXTRACTS FROM LUCIAN. Edited, with Notes, Exercises, and Vocabulary, by Rev. JOHN BOND, M.A., and A. S. WALPOLE, M.A.

Nepos.—SELECTIONS ILLUSTRATIVE OF GREEK AND ROMAN HISTORY. Edited for the use of beginners with Notes, Vocabulary and Exercises, by G. S. FARNELL, M.A.

Ovid.—SELECTIONS. Edited by E. S. SHUCKBURGH, M.A. late Fellow and Assistant-Tutor of Emmanuel College, Cambridge.

ELEGIAC SELECTIONS. Arranged for the use of Beginners with Notes, Vocabulary, and Exercises, by H. WILKINSON, M.A.

[*In preparation.*]

STORIES FROM THE METAMORPHOSES. Arranged for the Use of Beginners. With Notes, Exercises, and Vocabularies. By J. BOND, M.A., and A. S. WALPOLE, M.A. [*In preparation.*]

Phædrus.—SELECT FABLES. Adapted for the Use of Beginners. With Notes, Exercises, and Vocabularies, by A. S. WALPOLE, M.A.

Thucydides.—THE RISE OF THE ATHENIAN EMPIRE. BOOK I. cc. LXXXIX. — CXVII. AND CXXVIII. — CXXXVIII. Edited with Notes, Vocabulary and Exercises, by F. H. COLSON, M.A., Senior Classical Master at Bradford Grammar School; Fellow of St. John's College, Cambridge.

Virgil.—ÆNEID. BOOK I. Edited by A. S. WALPOLE, M.A. ÆNEID. BOOK V. Edited by Rev. A. CALVERT, M.A., late Fellow of St. John's College, Cambridge.

GEORGICS. BOOK I. Edited by C. BRYANS, M.A.

[*In preparation.*]

SELECTIONS. Edited by E. S. SHUCKBURGH, M.A.

Xenophon.—ANABASIS. BOOK I. Edited by A. S. WALPOLE, M.A.

Xenophon.—SELECTIONS FROM THE CYROPÆDIA. Edited, with Notes, Vocabulary, and Exercises, by A. H. COOKE, M.A., Fellow and Lecturer of King's College, Cambridge.

The following more advanced Books, with Introductions and Notes, but **no Vocabulary**, are either ready, or in preparation:—

Cicero.—SELECT LETTERS. Edited by Rev. G. E. JEANS, M.A., Fellow of Hertford College, Oxford, and Assistant-Master at Haileybury College.

Euripides.—HECUBA. Edited by Rev. JOHN BOND, M.A. and A. S. WALPOLE, M.A.

Herodotus.—SELECTIONS FROM BOOKS VI. AND VII., THE EXPEDITION OF XERXES. Edited by A. H. COOKE, M.A., Fellow and Lecturer of King's College, Cambridge.

Horace.—SELECTIONS FROM THE SATIRES AND EPISTLES. Edited by Rev. W. J. V. BAKER, M.A., Fellow of St. John's College, Cambridge; Assistant-Master in Marlborough College.

SELECT EPODES AND ARS POETICA. Edited by H. A. DALTON, M.A., formerly Senior Student of Christchurch; Assistant-Master in Winchester College.

Plato.—EUTHYPIRO AND MENEXENUS. Edited by C. E. GRAVES, M.A., Classical Lecturer and late Fellow of St. John's College, Cambridge.

Terence.—SCENES FROM THE ANDRIA. Edited by F. W. CORNISH, M.A., Assistant-Master at Eton College.

The Greek Elegiac Poets.—FROM CALLINUS TO CALLIMACHUS. Selected and Edited by Rev. HERBERT KYNASTON, D.D., Principal of Cheltenham College, and formerly Fellow of St. John's College, Cambridge.

Thucydides.—BOOK IV. CHS. I.—XLI. THE CAPTURE OF SPHACTERIA. Edited by C. E. GRAVES, M.A.

Virgil.—GEORGICS. BOOK II. Edited by Rev. J. H. SKRINE, M.A., late Fellow of Merton College, Oxford; Assistant-Master at Uppingham.

* * *Other Volumes to follow.*

CLASSICAL SERIES
FOR COLLEGES AND SCHOOLS.

Fcap. 8vo.

Being select portions of Greek and Latin authors, edited with Introductions and Notes, for the use of Middle and Upper forms of Schools, or of candidates for Public Examinations at the Universities and elsewhere.

Æschines.—IN CTESIPHONTEM. Edited by Rev. T. GWATKIN, M.A., late Fellow of St. John's College, Cambridge. [*In the press.*]

Æschylus.—PERSÆ. Edited by A. O. PRICKARD, M.A. Fellow and Tutor of New College, Oxford. With Map. 3s. 6d.

Andocides.—DE MYSTERIIS. Edited by W. J. HICKIE, M.A., formerly Assistant Master in Denstone College. 2s. 6d.

Cæsar.—THE GALLIC WAR. Edited, after Kraner, by Rev. JOHN BOND, M.A., and A. S. WALPOLE, M.A. With Maps. 6s.

Catullus.—SELECT POEMS. Edited by F. P. SIMPSON, B.A., late Scholar of Balliol College, Oxford. New and Revised Edition. 5s. The Text of this Edition is carefully adapted to School use.

Cicero.—THE CATILINE ORATIONS. From the German of KARL HALM. Edited, with Additions, by A. S. WILKINS, M.A., LL.D., Professor of Latin at the Owens College, Manchester, Examiner of Classics to the University of London. New Edition. 3s. 6d.

PRO LEGE MANILIA. Edited, after HALM, by Professor A. S. WILKINS, M.A., LL.D. 2s. 6d.

THE SECOND PHILIPPIC ORATION. From the German of KARL HALM. Edited, with Corrections and Additions, by JOHN E. B. MAYOR, Professor of Latin in the University of Cambridge, and Fellow of St. John's College. New Edition, revised. 5s.

PRO ROSCIO AMERINO. Edited, after HALM, by E. H. DONKIN, M.A., late Scholar of Lincoln College, Oxford; Assistant-Master at Sherborne School. 4s. 6d.

PRO P. SESTIO. Edited by Rev. H. A. HOLDEN, M.A., LL.D., late Fellow of Trinity College, Cambridge; and late Classical Examiner to the University of London. 5s.

Demosthenes.—DE CORONA. Edited by B. DRAKE, M.A., late Fellow of King's College, Cambridge. New and revised Edition. 4s. 6d.

ADVERSUS LEPTINEM. Edited by Rev. J. R. KING, M.A., Fellow and Tutor of Oriel College, Oxford. 4s. 6d.

THE FIRST PHILIPPIC. Edited, after C. REHDANTZ, by Rev. T. GWATKIN, M.A., late Fellow of St. John's College, Cambridge. 2s. 6d.

IN MIDIAM. Edited by Prof. A. S. WILKINS, LL.D., and HERMAN HAGER, Ph.D., of the Owens College, Manchester. *[In preparation.]*

Euripides.—IPPOLYTUS. Edited by J. P. MAHAFFY, M.A., Fellow and Professor of Ancient History in Trinity College, Dublin, and J. B. BURY, Fellow of Trinity College, Dublin. 3s. 6d.

MEDEA. Edited by A. W. VERRALL, M.A., Fellow and Lecturer of Trinity College, Cambridge. 3s. 6d.

IPHIGENIA IN TAURIS. Edited by E. B. ENGLAND, M.A., Lecturer at the Owens College, Manchester. 4s. 6d.

Herodotus.—BOOKS V. AND VI. Edited by J. STRACHAN, M.A., Professor of Greek in the Owens College, Manchester. *[In preparation.]*

BOOKS VII. AND VIII. Edited by Rev. A. H. COOKE, M.A., Fellow of King's College, Cambridge. *[In preparation.]*

Homer.—ILIAD. BOOKS I., IX., XI., XVI.—XXIV. THE STORY OF ACHILLES. Edited by the late J. H. PRATT, M.A., and WALTER LEAF, M.A., Fellows of Trinity College, Cambridge. 6s.

ODYSSEY. BOOK IX. Edited by Prof. JOHN E. B. MAYOR. 2s. 6d.

ODYSSEY. BOOKS XXI.—XXIV. THE TRIUMPH OF ODYSSEUS. Edited by S. G. HAMILTON, B.A., Fellow of Hertford College, Oxford. 3s. 6d.

Horace.—THE ODES. Edited by T. E. PAGE, M.A., formerly Fellow of St. John's College, Cambridge; Assistant-Master at Charterhouse. 6s. (BOOKS I., II., III., and IV. separately, 2s. each.)

THE SATIRES. Edited by ARTHUR PALMER, M.A., Fellow of Trinity College, Dublin; Professor of Latin in the University of Dublin. 6s.

THE EPISTLES AND ARS POETICA. Edited by A. S. WILKINS, M.A., LL.D., Professor of Latin in Owens College, Manchester; Examiner in Classics to the University of London. 6s.

Isaeos.—THE ORATIONS. Edited by WILLIAM RIDGEWAY, M.A., Fellow of Caius College, Cambridge; and Professor of Greek in the University of Cork. [*In preparation.*]

Juvenal. THIRTEEN SATIRES. Edited, for the Use of Schools, by E. G. HARDY, M.A., Head Master of Grantham Grammar School; late Fellow of Jesus College, Oxford. 5s.

The Text of this Edition is carefully adapted to School use.

SELECT SATIRES. Edited by Professor JOHN E. B. MAYOR. X. AND XI. 3s. 6d. XII.—XVI. 4s. 6d.

Livy.—BOOKS II. AND III. Edited by Rev. H. M. STEPHENSON, M.A., Head-Master of St. Peter's School, York. 5s.

BOOKS XXI. AND XXII. Edited by the Rev. W. W. CAPES, M.A., Reader in Ancient History at Oxford. Maps. 5s.

BOOKS XXIII AND XXIV. Edited by G. C. MACAULAY, M.A., Assistant-Master at Rugby. With Maps. 5s.

THE LAST TWO KINGS OF MACEDON. EXTRACTS FROM THE FOURTH AND FIFTH DECADES OF LIVY. Selected and Edited, with Introduction and Notes, by F. H. RAWLINS, M.A., Fellow of King's College, Cambridge; and Assistant-Master at Eton. With Maps. 3s. 6d.

Lucretius. BOOKS I.—III. Edited by J. H. WARBURTON LEE, M.A., late Scholar of Corpus Christi College, Oxford, and Assistant-Master at Rossall. 4s. 6d.

Lysias.—SELECT ORATIONS. Edited by E. S. SHUCKBURGH, M.A., late Assistant-Master at Eton College, formerly Fellow and Assistant-Tutor of Emmanuel College, Cambridge. New Edition, revised. 6s.

Martial.—SELECT EPIGRAMS. Edited by Rev. H. M. STEPHENSON, M.A. 6s.

Ovid.—FASTI. Edited by G. H. HALLAM, M.A., Fellow of St. John's College, Cambridge, and Assistant-Master at Harrow. With Maps. 5s.

HEROIDUM EPISTULÆ XIII. Edited by E. S. SHUCKBURGH, M.A. 4s. 6d.

METAMORPHOSES. BOOKS XIII. AND XIV. Edited by C. SIMMONS, M.A. 4s. 6d.

Plato.—MENO. Edited by E. S. THOMPSON, M.A., Fellow of Christ's College, Cambridge. [*In preparation.*]

APOLOGY AND CRITO. Edited by F. J. H. JENKINSON, M.A., Fellow of Trinity College, Cambridge. [*In preparation.*]

THE REPUBLIC. BOOKS I.—V. Edited by T. H. WARREN, M.A., President of Magdalen College, Oxford. [*In the press.*]

- Plautus.**—MILES GLORIOSUS. Edited by R. Y. TYRRELL, M.A., Fellow of Trinity College, and Regius Professor of Greek in the University of Dublin. Second Edition Revised. 5s.
- AMPHITRUO.** Edited by ARTHUR PALMER, M.A., Fellow of Trinity College and Regius Professor of Latin in the University of Dublin. [*In preparation.*]
- CAPTIVI.** Edited by A. RHYS SMITH, late Junior Student of Christ Church, Oxford. [*In preparation.*]
- Pliny.**—LETTERS. BOOK III. Edited by Professor JOHN E. B. MAYOR. With Life of Pliny by G. H. RENDALL, M.A. 5s.
- Plutarch.**—LIFE OF THEMISTOKLES. Edited by Rev. H. A. HOLDEN, M.A., LL.D. 5s.
- Polybius.**—HISTORY OF THE ACHÆAN LEAGUE. Being Parts of Books II., III., and IV. Edited by W. W. CAPES, M.A. [*In the press.*]
- Propertius.**—SELECT POEMS. Edited by Professor J. P. POSTGATE, M.A., Fellow of Trinity College, Cambridge. Second Edition, revised. 6s.
- Sallust.**—CATILINA AND JUGURTHA. Edited by C. MERIVALE, D.D., Dean of Ely. New Edition, carefully revised and enlarged, 4s. 6d. Or separately, 2s. 6d. each.
- BELLUM CATULINAE.** Edited by A. M. COOK, M.A., Assistant Master at St. Paul's School. 4s. 6d.
- JUGURTHA.** By the same Editor. [*In preparation.*]
- Sophocles.**—ANTIGONE. Edited by Rev. JOHN BOND, M.A., and A. S. WALPOLE, M.A. [*In preparation.*]
- Tacitus.**—AGRICOLA AND GERMANIA. Edited by A. J. CHURCH, M.A., and W. J. BRODRIBB, M.A., Translators of Tacitus. New Edition, 3s. 6d. Or separately, 2s. each.
- THE ANNALS. BOOK VI.** By the same Editors. 2s. 6d.
- THE HISTORIES. BOOKS I. AND II.** Edited by A. D. GODLEY, M.A. 5s.
- THE ANNALS. BOOKS I. AND II.** Edited by J. S. REID, M.L., Litt.D. [*In preparation.*]
- Terence.**—HAUTON TIMORUMENOS. Edited by E. S. SHUCKBURGH, M.A. 3s. With Translation, 4s. 6d.
- PHORMIO.** Edited by Rev. JOHN BOND, M.A., and A. S. WALPOLE, M.A. 4s. 6d.

Thucydides. BOOK IV. Edited by C. E. GRAVES, M.A.,
Classical Lecturer, and late Fellow of St. John's College,
Cambridge. 5s.

BOOKS I. II. III. AND V. By the same Editor. To be published
separately. [*In preparation. (Book V. in the press.)*]

BOOKS VI. AND VII. THE SICILIAN EXPEDITION. Edited
by the Rev. PERCIVAL FROST, M.A., late Fellow of St. John's
College, Cambridge. New Edition, revised and enlarged, with
Map. 5s.

Tibullus.—SELECT POEMS. Edited by Professor J. P.
POSTGATE, M.A. [*In preparation.*]

Virgil.—ÆNEID. BOOKS II. AND III. THE NARRATIVE
OF ÆNEAS. Edited by E. W. HOWSON, M.A., Fellow of King's
College, Cambridge, and Assistant-Master at Harrow. 3s.

Xenophon.—HELLENICA, BOOKS I. AND II. Edited by
H. HAILSTONE, B.A., late Scholar of Peterhouse, Cambridge.
With Map. 4s. 6d.

CYROPÆDIA. BOOKS VII. AND VIII. Edited by ALFRED
GOODWIN, M.A., Professor of Greek in University College,
London. 5s.

MEMORABILIA SOCRATIS. Edited by A. R. CLUER, B.A.,
Balliol College, Oxford. 6s.

THE ANABASIS. BOOKS I.—IV. Edited by Professors W. W.
GOODWIN and J. W. WHITE. Adapted to Goodwin's Greek
Grammar. With a Map. 5s.

HIERO. Edited by Rev. H. A. HOLDEN, M.A., LL.D. 3s. 6d.

OECONOMICUS. By the same Editor. With Introduction,
Explanatory Notes, Critical Appendix, and Lexicon. 6s.

*** Other Volumes will follow.*

CLASSICAL LIBRARY.

(1) Texts, Edited with Introductions and Notes,
for the use of Advanced Students. (2) Commentaries
and Translations.

Æschylus.—THE EUMENIDES. The Greek Text, with
Introduction, English Notes, and Verse Translation. By BERNARD
DRAKE, M.A., late Fellow of King's College, Cambridge.
8vo. 5s.

Æschylus.—**AGAMEMNON, CHOEPHORÆ, AND EUMENIDES.** Edited, with Introduction and Notes, by A. O. PRICKARD, M.A., Fellow and Tutor of New College, Oxford. 8vo. *[In preparation.]*

AGAMEMNO. Emendavit DAVID S. MARGOLIOUTH, Coll. Nov. Oxon. Soc. Demy 8vo. 2s. 6d.

THE "SEVEN AGAINST THEBES." Edited, with Introduction, Commentary, and Translation, by A. W. VERRALL, M.A., Fellow of Trinity College, Cambridge. 8vo. 7s. 6d.

Antoninus, Marcus Aurelius.—**BOOK IV. OF THE MEDITATIONS.** The Text Revised, with Translation and Notes, by HASTINGS CROSSLEY, M.A., Professor of Greek in Queen's College, Belfast. 8vo. 6s.

Aristotle.—**THE METAPHYSICS. BOOK I.** Translated by a Cambridge Graduate. 8vo. 5s. *[Book II. in preparation.]*

THE POLITICS. Edited, after SUSEMIHL, by R. D. HICKS, M.A., Fellow of Trinity College, Cambridge. 8vo. *[In the press.]*

THE POLITICS. Translated by Rev. J. E. C. WELLDON, M.A., Fellow of King's College, Cambridge, and Head-Master of Harrow School. Crown 8vo. 1cs. 6d.

THE RHETORIC. Translated with an Analysis and Critical Notes, by the same. Crown 8vo. 7s. 6d.

AN INTRODUCTION TO ARISTOTLE'S RHETORIC. With Analysis, Notes, and Appendices. By E. M. COPE, Fellow and Tutor of Trinity College, Cambridge. 8vo. 14s.

THE SOPHISTICI ELENCHII. With Translation and Notes by E. POSTE, M.A., Fellow of Oriel College, Oxford. 8vo. 8s. 6d.

Aristophanes.—**THE BIRDS.** Translated into English Verse, with Introduction, Notes, and Appendices, by B. II. KENNEDY, D.D., Regius Professor of Greek in the University of Cambridge. Crown 8vo. 6s. Help Notes to the same, for the use of Students, 1s. 6d.

Attic Orators.—**FROM ANTIPHON TO ISAEOS.** By R. C. JEBB, M.A., LL.D., Professor of Greek in the University of Glasgow. 2 vols. 8vo. 25s.

SELECTIONS FROM ANTIPHON, ANDOKIDES, LYSIAS, ISOKRATES, AND ISAEOS. Edited, with Notes, by Professor JEBB. Being a companion volume to the preceding work. 8vo. 12s. 6d.

Babrius.—Edited, with Introductory Dissertations, Critical Notes, Commentary and Lexicon. By Rev. W. GUNION RUTHERFORD, M.A., LL.D., Head-Master of Westminster School. 8vo. 12s. 6d.

Cicero.—THE ACADEMICA. The Text revised and explained by J. S. REID, M.L., Litt.D., Fellow of Caius College, Cambridge. 8vo. 15s.

THE ACADEMICS. Translated by J. S. REID, M.L. 8vo. 5s. 6d.

SELECT LETTERS. After the Edition of ALBERT WATSON, M.A. Translated by G. E. JEANS, M.A., Fellow of Hertford College, Oxford, and Assistant-Master at Haileybury. 8vo. 10s. 6d.

(See also *Classical Series*.)

Euripides.—MEDEA. Edited, with Introduction and Notes, by A. W. VERRALL, M.A., Fellow and Lecturer of Trinity College, Cambridge. 8vo. 7s. 6d.

IPHIGENIA IN AULIS. Edited, with Introduction and Notes, by E. B. ENGLAND, M.A., Lecturer in the Owens College, Manchester. 8vo. [In preparation.]

INTRODUCTION TO THE STUDY OF EURIPIDES. By Professor J. P. MAHAFFY. Fcap. 8vo. 1s. 6d. (*Classical Writers Series*.)

(See also *Classical Series*.)

Herodotus.—BOOKS I.—III. THE ANCIENT EMPIRES OF THE EAST. Edited, with Notes, Introductions, and Appendices, by A. H. SAYCE, Deputy-Professor of Comparative Philology, Oxford; Honorary LL.D., Dublin. Demy 8vo. 16s.

BOOKS IV.—IX. Edited by REGINALD W. MACAN, M.A., Lecturer in Ancient History at Brasenose College, Oxford. 8vo. [In preparation.]

Homer.—THE ILIAD. Edited, with Introduction and Notes, by WALTER LEAF, M.A., late Fellow of Trinity College, Cambridge. 8vo. Vol. I. Books I.—XII. 14s. [Vol. II. in preparation]

THE ILIAD. Translated into English Prose. By ANDREW LANG, M.A., WALTER LEAF, M.A., and ERNEST MYERS, M.A. Crown 8vo. 12s. 6d.

THE ODYSSEY. Done into English by S. H. BUTCHER, M.A., Professor of Greek in the University of Edinburgh, and ANDREW LANG, M.A., late Fellow of Merton College, Oxford. Fifth Edition, revised and corrected. Crown 8vo. 10s. 6d.

INTRODUCTION TO THE STUDY OF HOMER. By the Right Hon. W. E. GLADSTONE, M.P. 18mo. 1s. (*Literature Primers*.)

Homer.—HOMERIC DICTIONARY. For Use in Schools and Colleges. Translated from the German of Dr. G. AUTENRIETH, with Additions and Corrections, by R. P. KEEP, Ph.D. With numerous Illustrations. Crown 8vo. 6s.

(See also *Classical Series*.)

Horace.—THE WORKS OF HORACE RENDERED INTO ENGLISH PROSE. With Introductions, Running Analysis, Notes, &c. By J. LONSDALE, M.A., and S. LEE, M.A. (*Globe Edition*.) 3s. 6d.

STUDIES, LITERARY AND HISTORICAL, IN THE ODES OF HORACE. By A. W. VERRALL, Fellow of Trinity College, Cambridge. Demy 8vo. 8s. 6d.

(See also *Classical Series*.)

Juvenal.—THIRTEEN SATIRES OF JUVENAL. With a Commentary. By JOHN E. B. MAYOR, M.A., Professor of Latin in the University of Cambridge. Crown 8vo.

* * Vol. I. Fourth Edition, Revised and Enlarged. 10s. 6d.
* * Vol. II. Second Edition. 10s. 6d.

* * The new matter consists of an Introduction (pp. 1—53), Additional Notes (pp. 333—466) and Index (pp. 467—526). It is also issued separately, as a Supplement to the previous edition, at 5s.

THIRTEEN SATIRES. Translated into English after the Text of J. E. B. MAYOR by ALEXANDER LEEPER, M.A., Warden of Trinity College, in the University of Melbourne. Crown 8vo. 3s. 6d.

(See also *Classical Series*.)

Livy.—BOOKS I.—IV. Translated by Rev. H. M. STEPHENSON, M.A., Head Master of St. Peter's School, York. [*In preparation*].

BOOKS XXI.—XXV. Translated by ALFRED JOHN CHURCH, M.A., of Lincoln College, Oxford, Professor of Latin, University College, London, and WILLIAM JACKSON BRODRIBB, M.A., late Fellow of St. John's College, Cambridge. Cr. 8vo. 7s. 6d.

INTRODUCTION TO THE STUDY OF LIVY. By Rev. W. W. CAPES, Reader in Ancient History at Oxford. Fcap. 8vo. 1s. 6d. (*Classical Writers Series*.)

(See also *Classical Series*.)

Martial.—BOOKS I. AND II. OF THE EPIGRAMS. Edited, with Introduction and Notes, by Professor J. E. B. MAYOR, M.A. 8vo. [*In the press*].

(See also *Classical Series*.)

Pausanias.—DESCRIPTION OF GREECE. Translated by J. G. FRAZER, M.A., Fellow of Trinity College, Cambridge. [*In preparation*].

Phrynichus.—THE NEW PHRYNICHUS; being a Revised Text of the Ecloga of the Grammatian Phrynichus. With Introduction and Commentary by Rev. W. GUNION RUTHERFORD, M.A., LL.D., Head Master of Westminster School. 8vo. 18s.

Pindar.—THE EXTANT ODES OF PINDAR. Translated into English, with an Introduction and short Notes, by ERNEST MYERS, M.A., late Fellow of Wadham College, Oxford. Second Edition. Crown 8vo. 5s.

THE OLYMPIAN AND PYTHIAN ODES. Edited, with an Introductory Essay, Notes, and Indexes, by BASIL GILDERSLEEVE, Professor of Greek in the Johns Hopkins University, Baltimore. Crown 8vo. 7s. 6d.

Plato.—PHÆDO. Edited, with Introduction, Notes, and Appendices, by R. D. ARCHER-HIND, M.A., Fellow of Trinity College, Cambridge. 8vo. 8s. 6d.

TIMÆUS.—Edited, with Introduction and Notes, by the same Editor. 8vo. *[In the press.]*

PHÆDO. Edited, with Introduction and Notes, by W. D. GEDDES, LL.D., Principal of the University of Aberdeen. Second Edition. Demy 8vo. 8s. 6d.

PHILEBUS. Edited, with Introduction and Notes, by HENRY JACKSON, M.A., Fellow of Trinity College, Cambridge. 8vo. *[In preparation.]*

THE REPUBLIC.—Edited, with Introduction and Notes, by H. C. GOODHART, M.A., Fellow of Trinity College, Cambridge. 8vo. *[In preparation.]*

THE REPUBLIC OF PLATO. Translated into English, with an Analysis and Notes, by J. LL. DAVIES, M.A., and D. J. VAUGHAN, M.A. 18mo. 4s. 6d.

EUTHYPHRO, APOLOGY, CRITO, AND PHÆDO. Translated by F. J. CHURCH. 18mo. 4s. 6d.

PHÆDRUS, LYSIS, AND PROTAGORAS. Translated by Rev. J. WRIGHT, M.A. *[New edition in preparation.]*
(See also *Classical Series.*)

Plautus.—THE MOSTELLARIA OF PLAUTUS. With Notes, Prolegomena, and Excursus. By WILLIAM RAMSAY, M.A., formerly Professor of Humanity in the University of Glasgow. Edited by Professor GEORGE G. RAMSAY, M.A., of the University of Glasgow. 8vo. 14s.

(See also *Classical Series.*)

Polybius.—THE HISTORIES. Translated, with Introduction and Notes, by E. S. SHUCKBURGH, M.A. 8vo. *[In preparation.]*

Sallust.—CATILINE AND JUGURTHA. Translated, with Introductory Essays, by A. W. POLLARD, B.A. Crown 8vo. 6s.
THE CATILINE (separately). Crown 8vo. 3s.

(See also *Classical Series*.)

Sophocles.—ÆDIPUS THE KING. Translated from the Greek of Sophocles into English Verse by E. D. A. MORSHEAD, M.A., late Fellow of New College, Oxford; Assistant Master at Winchester College. Fcap. 8vo. 3s. 6d.

Studia Scenica.—Part I., Section I. Introductory Study on the Text of the Greek Dramas. The Text of SOPHOCLES' TRACHINIAE, 1-300. By DAVID S. MARGOLIOUTH, Fellow of New College, Oxford. Demy 8vo. 2s. 6d.

Tacitus.—THE ANNALS. Edited, with Introductions and Notes, by G. O. HOLBROOKE, M.A., Professor of Latin in Trinity College, Hartford, U.S.A. With Maps. 8vo. 16s.

THE ANNALS. Translated by A. J. CHURCH, M.A., and W. J. BRODRIBB, M.A. With Notes and Maps. New Edition. Cr. 8vo. 7s. 6d.

THE HISTORIES. Edited, with Introduction and Notes, by Rev. W. A. SPOONER, M.A., Fellow of New College, and H. M. SPOONER, M.A., formerly Fellow of Magdalen College, Oxford. 8vo. *[In preparation.]*

THE HISTORY. Translated by A. J. CHURCH, M.A., and W. J. BRODRIBB, M.A. With Notes and a Map. Crown 8vo. 6s.

THE AGRICOLA AND GERMANY, WITH THE DIALOGUE ON ORATORY. Translated by A. J. CHURCH, M.A., and W. J. BRODRIBB, M.A. With Notes and Maps. New and Revised Edition. Crown 8vo. 4s. 6d.

INTRODUCTION TO THE STUDY OF TACITUS. By A. J. CHURCH, M.A. and W. J. BRODRIBB, M.A. Fcap. 8vo. 1s. 6d. (*Classical Writers Series*.)

Theocritus, Bion, and Moschus. Rendered into English Prose with Introductory Essay by A. LANG, M.A. Crown 8vo. 6s.

Virgil.—THE WORKS OF VIRGIL RENDERED INTO ENGLISH PROSE, with Notes, Introductions, Running Analysis, and an Index, by JAMES LONSDALE, M.A., and SAMUEL LEE, M.A. New Edition. Globe 8vo. 3s. 6d.

THE ÆNEID. Translated by J. W. MACKAIL, M.A., Fellow of Balliol College, Oxford. Crown 8vo. 7s. 6d.

GRAMMAR, COMPOSITION, & PHILOLOGY.

Belcher.—SHORT EXERCISES IN LATIN PROSE COMPOSITION AND EXAMINATION PAPERS IN LATIN GRAMMAR, to which is prefixed a Chapter on Analysis of Sentences. By the Rev. H. BELCHER, M.A., Rector of the High School, Dunedin, N.Z. New Edition. 18mo. 1s. 6d.

KEY TO THE ABOVE (for Teachers only). 3s. 6d.

SHORT EXERCISES IN LATIN PROSE COMPOSITION. Part II., On the Syntax of Sentences, with an Appendix, including EXERCISES IN LATIN IDIOMS, &c. 18mo. 2s.

KEY TO THE ABOVE (for Teachers only). 3s.

Blackie.—GREEK AND ENGLISH DIALOGUES FOR USE IN SCHOOLS AND COLLEGES. By JOHN STUART BLACKIE, Emeritus Professor of Greek in the University of Edinburgh. New Edition. Fcap. 8vo. 2s. 6d.

Bryans.—LATIN PROSE EXERCISES BASED UPON CAESAR'S GALLIC WAR. With a Classification of Cæsar's Chief Phrases and Grammatical Notes on Cæsar's Usages. By CLEMENT BRYANS, M.A., Assistant-Master in Dulwich College. Second Edition, Revised and Enlarged. Extra fcap. 8vo. 2s. 6d.

KEY TO THE ABOVE (for Teachers only). 3s. 6d.

GREEK PROSE EXERCISES based upon Thucydides. By the same Author. Extra fcap. 8vo. [*In preparation.*]

Colson.—A FIRST GREEK READER. By F. H. COLSON, M.A., Fellow of St. John's College, Cambridge, and Senior Classical Master at Bradford Grammar School. Globe 8vo.

[*In preparation.*]

Eicke.—FIRST LESSONS IN LATIN. By K. M. EICKE, B.A., Assistant-Master in Oundle School. Globe 8vo. 2s.

Ellis.—PRACTICAL HINTS ON THE QUANTITATIVE PRONUNCIATION OF LATIN, for the use of Classical Teachers and Linguists. By A. J. ELLIS, B.A., F.R.S. Extra fcap. 8vo. 4s. 6d.

England.—EXERCISES ON LATIN SYNTAX AND IDIOM—ARRANGED WITH REFERENCE TO ROBY'S SCHOOL LATIN GRAMMAR. By E. B. ENGLAND, M.A., Assistant Lecturer at the Owens College, Manchester. Crown 8vo. 2s. 6d. Key for Teachers only, 2s. 6d.

Goodwin.—Works by W. W. GOODWIN, LL.D., Professor of Greek in Harvard University, U.S.A.

SYNTAX OF THE MOODS AND TENSES OF THE GREEK VERB. New Edition, revised. Crown 8vo. 6s. 6d.

A GREEK GRAMMAR. New Edition, revised. Crown 8vo. 6s.

"It is the best Greek Grammar of its size in the English language."—

Goodwin.—A GREEK GRAMMAR FOR SCHOOLS. Crown 8vo. 3s. 6d.

Greenwood.—THE ELEMENTS OF GREEK GRAMMAR, including Accidence, Irregular Verbs, and Principles of Derivation and Composition; adapted to the System of Crude Forms. By J. G. GREENWOOD, Principal of Owens College, Manchester. New Edition. Crown 8vo. 5s. 6d.

Hadley and Allen.—A GREEK GRAMMAR FOR SCHOOLS AND COLLEGES. By JAMES HADLEY, late Professor in Yale College. Revised and in part Rewritten by FREDERIC DE FOREST ALLEN, Professor in Harvard College. Crown 8vo. 6s.

Hodgson.—MYTHOLOGY FOR LATIN VERSIFICATION. A brief Sketch of the Fables of the Ancients, prepared to be rendered into Latin Verse for Schools. By F. HODGSON, B.D., late Provost of Eton. New Edition, revised by F. C. HODGSON, M.A. 18mo. 3s.

Jackson.—FIRST STEPS TO GREEK PROSE COMPOSITION. By BLOMFIELD JACKSON, M.A., Assistant-Master in King's College School, London. New Edition, revised and enlarged. 18mo. 1s. 6d.

KEY TO FIRST STEPS (for Teachers only). 18mo. 3s. 6d.

SECOND STEPS TO GREEK PROSE COMPOSITION, with Miscellaneous Idioms, Aids to Accentuation, and Examination Papers in Greek Scholarship. 18mo. 2s. 6d.

KEY TO SECOND STEPS (for Teachers only). 18mo. 3s. 6d.

Kynaston.—EXERCISES IN THE COMPOSITION OF GREEK IAMBIC VERSE by Translations from English Dramatists. By Rev. H. KYNASTON, D.D., Principal of Cheltenham College. With Introduction, Vocabulary, &c. New Edition, revised and enlarged. Extra fcap. 8vo. 5s.

KEY TO THE SAME (for Teachers only). Extra fcap. 8vo. 4s. 6d.

Lupton.—AN INTRODUCTION TO LATIN ELEGIAC VERSE COMPOSITION. By J. H. LUPTON, M.A., Sur-Master of St. Paul's School, and formerly Fellow of St. John's College, Cambridge. 2s. 6d.

LATIN RENDERING OF THE EXERCISES IN PART II (XXV.-C.). 3s. 6d.

AN INTRODUCTION TO THE COMPOSITION OF LATIN LYRICS. By the same Author. *[In preparation]*

Mackie.—PARALLEL PASSAGES FOR TRANSLATION INTO GREEK AND ENGLISH. Carefully graduated for the use of Colleges and Schools. With Indexes. By Rev. ELLIS C. MACKIE, Classical Master at Heversham Grammar School. Globe 8vo. 4s. 6d.

Macmillan.—FIRST LATIN GRAMMAR. By M. C. MACMILLAN, M.A., late Scholar of Christ's College, Cambridge; sometime Assistant-Master in St. Paul's School. New Edition, enlarged. Fcap. 8vo. 1s. 6d. A SHORT SYNTAX is in preparation to follow the ACCIDENCE.

Macmillan's Latin Course. FIRST PART. By A. M. COOK, M.A., Assistant-Master at St. Paul's School. Globe 8vo. 2s. 6d. * * *The Second Part is in preparation*

Macmillan's Shorter Latin Course. By A. M. COOK, M.A., Assistant-Master at St. Paul's School. Being an abridgement of "Macmillan's Latin Course," First Year. Globe 8vo. 1s. 6d.

Marshall.—A TABLE OF IRREGULAR GREEK VERBS, classified according to the arrangement of Curtius's Greek Grammar. By J. M. MARSHALL, M.A., Head Master of the Grammar School, Durham. New Edition. 8vo. 1s.

Mayor (John E. B.)—FIRST GREEK READER. Edited after KARL HALLM, with Corrections and large Additions by Professor JOHN E. B. MAYOR, M.A., Fellow of St. John's College, Cambridge. New Edition, revised. Fcap. 8vo. 4s. 6d.

Mayor (Joseph B.)—GREEK FOR BEGINNERS. By the Rev. J. B. MAYOR, M.A., Professor of Classical Literature in King's College, London. Part I., with Vocabulary, 1s. 6d. Parts II. and III., with Vocabulary and Index, 3s. 6d. Complete in one Vol. fcap. 8vo. 4s. 6d.

Nixon.—PARALLEL EXTRACTS, Arranged for Translation into English and Latin, with Notes on Idioms. By J. E. NIXON, M.A., Fellow and Classical Lecturer, King's College, Cambridge. Part I.—Historical and Epistolary. New Edition, revised and enlarged. Crown 8vo. 3s. 6d.

PROSE EXTRACTS, Arranged for Translation into English and Latin, with General and Special Prefaces on Style and Idiom. I. Oratorical. II. Historical. III. Philo-ophical and Miscellaneous. By the same Author. Crown 8vo. 3s. 6d.

* * *Translations of Select Passages supplied by Author only.*

Peile.—A PRIMER OF PHILOLOGY. By J. PEILE, M.A., Fellow and Tutor of Christ's College, Cambridge. 18mo. 1s.

Postgate and Vince.—A DICTIONARY OF LATIN ETYMOLOGY. By J. P. POSTGATE, M.A., and C. A. VINCE, M.A. [*In preparation.*]

Potts (A. W.)—Works by ALEXANDER W. POTTS, M.A., LL.D., late Fellow of St. John's College, Cambridge; Head Master of the Fettes College, Edinburgh.

HIINTS TOWARDS LATIN PROSE COMPOSITION. New Edition. Extra fcap. 8vo. 3s.

Potts.—PASSAGES FOR TRANSLATION INTO LATIN PROSE. Edited with Notes and References to the above. New Edition. Extra fcap. 8vo. 2s. 6d.

LATIN VERSIONS OF PASSAGES FOR TRANSLATION INTO LATIN PROSE (for Teachers only). 2s. 6d.

Reid.—A GRAMMAR OF TACITUS. By J. S. REID, M.L., Fellow of Caius College, Cambridge. [*In preparation.*]

A GRAMMAR OF VERGIL. By the same Author. [*In preparation.*]

* * *Similar Grammars to other Classical Authors will probably follow.*

Roby.—A GRAMMAR OF THE LATIN LANGUAGE, from Plautus to Suetonius. By H. J. ROBY, M.A., late Fellow of St. John's College, Cambridge. In Two Parts. Fifth Edition. Part I. containing:—Book I. Sounds. Book II. Inflexions. Book III. Word-formation. Appendices. Crown 8vo. 9s. Part II. Syntax, Prepositions, &c. Crown 8vo. 10s. 6d.

"Marked by the clear and practised insight of a master in his art. A book that would do honour to any country."—*ATHENÆUM.*

SCHOOL LATIN GRAMMAR. By the same Author. Crown 8vo. 5s.

Rush.—SYNTHETIC LATIN DELECTUS. A First Latin Construing Book arranged on the Principles of Grammatical Analysis. With Notes and Vocabulary. By E. RUSH, B.A. With Preface by the Rev. W. F. MOULTON, M.A., D.D. New and Enlarged Edition. Extra fcap. 8vo. 2s. 6d.

Rust.—FIRST STEPS TO LATIN PROSE COMPOSITION. By the Rev. G. RUST, M.A., of Pembroke College, Oxford, Master of the Lower School, King's College, London. New Edition. 18mo. 1s. 6d.

KEY TO THE ABOVE. By W. M. YATES, Assistant-Master in the High School, Sale. 18mo. 3s. 6d.

Rutherford.—Works by the Rev. W. GUNION RUTHERFORD, M.A., LL.D., Head-Master of Westminster School.

A FIRST GREEK GRAMMAR. New Edition, enlarged. Extra fcap. 8vo. 1s. 6d.

REX LEX. A Short Digest of the principal Relations between Latin, Greek, and Anglo-Saxon Sounds. 8vo. [*In preparation.*]

THE NEW PHRYNICHIUS; being a Revised Text of the Ecloga of the Grammarian Phrynichus. With Introduction and Commentary. 8vo. 18s.

Simpson.—LATIN PROSE AFTER THE BEST AUTHORS.

By F. P. SIMPSON, B.A., late Scholar of Balliol College, Oxford.

Part I. CÆSARIAN PROSE. Extra fcap. 8vo. 2s. 6d.

KEY TO THE ABOVE, for Teachers only. Extra fcap. 8vo. 5s.

Thring.—Works by the Rev. E. THRING, M.A., Head-Master of Uppingham School.

A LATIN GRADUAL. A First Latin Construing Book for Beginners. New Edition, enlarged, with Coloured Sentence Maps. Fcap. 8vo. 2s. 6d.

A MANUAL OF MOOD CONSTRUCTIONS. Fcap. 8vo. 1s. 6d.

White.—FIRST LESSONS IN GREEK. Adapted to GOODWIN'S GREEK GRAMMAR, and designed as an introduction to the ANABASIS OF XENOPHON. By JOHN WILLIAMS WHITE, Ph.D., Assistant-Professor of Greek in Harvard University. Crown 8vo. 4s. 6d.

Wilkins and Strachan.—PASSAGES FOR TRANSLATION FROM GREEK AND LATIN. Selected and Arranged by A. S. WILKINS, M.A., Professor of Latin, and J. STRACHAN, M.A., Professor of Greek, in the Owens College, Manchester.

[In the press.]

Wright.—Works by J. WRIGHT, M.A., late Head Master of Sutton Coldfield School.

A HELP TO LATIN GRAMMAR; or, The Form and Use of Words in Latin, with Progressive Exercises. Crown 8vo. 4s. 6d.

THE SEVEN KINGS OF ROME. An Easy Narrative, abridged from the First Book of Livy by the omission of Difficult Passages; being a First Latin Reading Book, with Grammatical Notes and Vocabulary. New and revised Edition. Fcap. 8vo. 3s. 6d.

FIRST LATIN STEPS; OR, AN INTRODUCTION BY A SERIES OF EXAMPLES TO THE STUDY OF THE LATIN LANGUAGE. Crown 8vo. 3s.

ATTIC PRIMER. Arranged for the Use of Beginners. Extra fcap. 8vo. 2s. 6d.

A COMPLETE LATIN COURSE, comprising Rules with Examples, Exercises, both Latin and English, on each Rule, and Vocabularies. Crown 8vo. 2s. 6d.

Wright (H. C.)—EXERCISES ON THE LATIN SYNTAX. By Rev. H. C. WRIGHT, B.A., Assistant-Master at Haileybury College. 18mo. *[In preparation.]*

ANTIQUITIES, ANCIENT HISTORY, AND PHILOSOPHY.

Arnold.—Works by W. T. ARNOLD, M.A.

A HANDBOOK OF LATIN EPIGRAPHY. *[In preparation.]*

THE ROMAN SYSTEM OF PROVINCIAL ADMINISTRATION TO THE ACCESSION OF CONSTANTINE THE GREAT. Crown 8vo. 6s.

Arnold (T.)—THE SECOND PUNIC WAR. Being Chapters of THE HISTORY OF ROME. By the late THOMAS ARNOLD, D.D., formerly Head Master of Rugby School, and Regius Professor of Modern History in the University of Oxford. Edited, with Notes, by W. T. ARNOLD, M.A. With 8 Maps. Crown 8vo. 8s. 6d.

Beesly.—STORIES FROM THE HISTORY OF ROME. By Mrs. BEESLY. Fcap. 8vo. 2s. 6d.

Classical Writers.—Edited by JOHN RICHARD GREEN, M.A., LL.D. Fcap. 8vo. 1s. 6d. each.

EURIPIDES. By Professor MAHAFFY.

MILTON. By the Rev. STOPFORD A. BROOKE, M.A.

LIVY. By the Rev. W. W. CAPES, M.A.

VIRGIL. By Professor NETTLESHIP, M.A.

SOPHOCLES. By Professor L. CAMPBELL, M.A.

DEMOSTHENES. By Professor S. H. BUTCHER, M.A.

TACITUS. By Professor A. J. CHURCH, M.A., and W. J. BRODRIBB, M.A.

Freeman.—HISTORY OF ROME. By EDWARD A. FREEMAN, D.C.L., LL.D., Hon. Fellow of Trinity College, Oxford, Regius Professor of Modern History in the University of Oxford. (*Historical Course for Schools.*) 18mo. [In preparation.]

A SCHOOL HISTORY OF ROME. By the same Author. Crown 8vo. [In preparation.]

HISTORICAL ESSAYS. Second Series. [Greek and Roman History.] By the same Author. 8vo. 10s. 6d.

Fyffe.—A SCHOOL HISTORY OF GREECE. By C. A. FYFFE, M.A. Crown 8vo. [In preparation.]

Geddes.—THE PROBLEM OF THE HOMERIC POEMS. By W. D. GEDDES, Principal of the University of Aberdeen. 8vo. 14s.

Gladstone.—Works by the Rt. Hon. W. E. GLADSTONE, M.P. THE TIME AND PLACE OF HOMER. Crown 8vo. 6s. 6d. A PRIMER OF HOMER. 18mo. 1s.

Jackson.—A MANUAL OF GREEK PHILOSOPHY. By HENRY JACKSON, M.A., Litt.D., Fellow and Prælector in Ancient Philosophy, Trinity College, Cambridge. [In preparation.]

Jebb.—Works by R. C. JEBB, M.A., LL.D., Professor of Greek in the University of Glasgow.

THE ATTIC ORATORS FROM ANTIPHON TO ISAEOS. 2 vols. 8vo. 25s.

SELECTIONS FROM THE ATTIC ORATORS, ANTIPHON, ANDOKIDES, LYSIAS, ISOKRATES, AND ISAEOS. Edited, with Notes. Being a companion volume to the preceding work. 8vo. 12s. 6d.

A PRIMER OF GREEK LITERATURE. 18mo. 1s.

Kiepert.—MANUAL OF ANCIENT GEOGRAPHY, Translated from the German of Dr. HEINRICH KIEPERT. Crown 8vo. 5s.

Mahaffy.—Works by J. P. MAHAFFY, M.A., Fellow and Professor of Ancient History in Trinity College, Dublin, and Hon. Fellow of Queen's College, Oxford.

SOCIAL LIFE IN GREECE; from Homer to Menander. Fifth Edition, revised and enlarged. Crown 8vo. 9s.

RAMBLES AND STUDIES IN GREECE. With Illustrations. Third Edition, Revised and Enlarged. With Map. Crown 8vo. 10s. 6d.

A PRIMER OF GREEK ANTIQUITIES. With Illustrations. 18mo. 1s.

EURIPIDES. 18mo. 1s. 6d. (*Classical Writers Series.*)

Mayor (J. E. B.)—BIBLIOGRAPHICAL CLUE TO LATIN LITERATURE. Edited after HUBNER, with large Additions by Professor JOHN E. B. MAYOR. Crown 8vo. 10s. 6d.

Newton.—ESSAYS IN ART AND ARCHEOLOGY. By C. T. NEWTON, C.B., D.C.L., Professor of Archaeology in University College, London, and formerly Keeper of Greek and Roman Antiquities at the British Museum. 8vo. 12s. 6d.

Ramsay.—A SCHOOL HISTORY OF ROME. By G. G. RAMSAY, M.A., Professor of Humanity in the University of Glasgow. With Maps. Crown 8vo. [*In preparation.*]

Sayce.—THE ANCIENT EMPIRES OF THE EAST. By A. H. SAYCE, Deputy-Professor of Comparative Philosophy, Oxford, Hon. LL.D. Dublin. Crown 8vo. 6s.

Stewart.—THE TALE OF TROY. Done into English by AUBREY STEWART, M.A., late Fellow of Trinity College, Cambridge. Globe 8vo. 3s. 6d.

Wilkins.—A PRIMER OF ROMAN ANTIQUITIES. By Professor WILKINS, M.A., LL.D. Illustrated. 18mo. 1s.

A PRIMER OF LATIN LITERATURE. By the same Author. [*In preparation.*]

MATHEMATICS.

(1) Arithmetic and Mensuration, (2) Algebra, (3) Euclid and Elementary Geometry, (4) Trigonometry, (5) Higher Mathematics.

ARITHMETIC AND MENSURATION.

Aldis.—THE GREAT GIANT ARITHIMOS. A most Elementary Arithmetic for Children. By MARY STEADMAN ALDIS. With Illustrations. Globe 8vo. 2s. 6d.

Brook-Smith (J.).—ARITHMETIC IN THEORY AND PRACTICE. By J. BROOK-SMITH, M.A., LL.B., St. John's College, Cambridge; Barrister-at-Law; one of the Masters of Cheltenham College. New Edition, revised. Crown 8vo. 4s. 6d.

Candler.—HELP TO ARITHMETIC. Designed for the use of Schools. By H. CANDLER, M.A., Mathematical Master of Uppingham School. Second Edition. Extra fcap. 8vo. 2s. 6d.

Dalton.—RULES AND EXAMPLES IN ARITHMETIC. By the Rev. T. DALTON, M.A., Assistant-Master in Eton College. New Edition. 18mo. 2s. 6d.

[Answers to the Examples are appended.]

Lock.—ARITHMETIC FOR SCHOOLS. By Rev. J. B. LOCK, M.A., Senior Fellow, Assistant Tutor, and Lecturer of Caius College, Cambridge, formerly Assistant-Master at Eton. With Answers and 1000 additional Examples for Exercises. Globe 8vo. 4s. 6d. Or in Two Parts:—Part I. Up to and including Practice, with Answers. Globe 8vo. 2s. Part II. With Answers and 1000 additional Examples for Exercise. Globe 8vo. 3s.

* * *The complete book and both parts can also be obtained without answers at the same price, though in different binding. But the edition with answers will always be supplied unless the other is specially asked for.*

Pedley.—EXERCISES IN ARITHMETIC for the Use of Schools. Containing more than 7,000 original Examples. By S. PEDLEY, late of Tamworth Grammar School. Crown 8vo. 5s. Also in Two Parts 2s. 6d. each.

Smith.—Works by the Rev. BARNARD SMITH, M.A., late Rector of Glaston, Rutland, and Fellow and Senior Bursar of S. Peter's College, Cambridge.

ARITHMETIC AND ALGEBRA, in their Principles and Application; with numerous systematically arranged Examples taken from the Cambridge Examination Papers, with especial reference to the Ordinary Examination for the B.A. Degree. New Edition, carefully Revised. Crown 8vo. 10s. 6d.

ARITHMETIC FOR SCHOOLS. New Edition. Cr. 8vo. 4s. 6d.

A KEY TO THE ARITHMETIC FOR SCHOOLS. New Edition. Crown 8vo. 8s. 6d.

EXERCISES IN ARITHMETIC. Crown 8vo, limp cloth, 2s. With Answers, 2s. 6d. Answers separately, 6d.

SCHOOL CLASS-BOOK OF ARITHMETIC. 18mo, cloth. 3s. Or sold separately, in Three Parts, 1s. each.

KEYS TO SCHOOL CLASS-BOOK OF ARITHMETIC Parts I., II., and III., 2s. 6d. each.

SHILLING BOOK OF ARITHMETIC FOR NATIONAL AND ELEMENTARY SCHOOLS. 18mo, cloth. Or separately, Part I. 2d.; Part II. 3d.; Part III. 7d. Answers, 6d.

THE SAME, with Answers complete. 18mo, cloth. 1s. 6d.

Smith.—KEY TO SHILLING BOOK OF ARITHMETIC.
18mo. 4s. 6d.

EXAMINATION PAPERS IN ARITHMETIC. 18mo. 1s. 6d.
The same, with Answers, 18mo, 2s. Answers, 6d.

KEY TO EXAMINATION PAPERS IN ARITHMETIC.
18mo. 4s. 6d.

THE METRIC SYSTEM OF ARITHMETIC, ITS PRINCIPLES AND APPLICATIONS, with numerous Examples, written expressly for Standard V. in National Schools. New Edition. 18mo, cloth, sewed. 3d.

A CHART OF THE METRIC SYSTEM, on a Sheet, size 42 in. by 34 in. on Roller, mounted and varnished. New Edition. Price 3s. 6d.

Also a Small Chart on a Card, price 1d.

EASY LESSONS IN ARITHMETIC, combining Exercises in Reading, Writing, Spelling, and Dictation. Part I. for Standard I. in National Schools. Crown 8vo. 9d.

EXAMINATION CARDS IN ARITHMETIC. (Dedicated to Lord Sandon.) With Answers and Hints.

Standards I. and II. in box, 1s. Standards III., IV., and V., in boxes, 1s. each. Standard VI. in Two Parts, in boxes, 1s. each.

A and B papers, of nearly the same difficulty, are given so as to prevent copying, and the colours of the A and B papers differ in each Standard, and from those of every other Standard, so that a master or mistress can see at a glance whether the children have the proper papers.

Todhunter.—MENSURATION FOR BEGINNERS. By I. TODHUNTER, M.A., F.R.S., D.Sc., late of St. John's College, Cambridge. With Examples. New Edition. 18mo. 2s. 6d.

KEY TO MENSURATION FOR BEGINNERS. By the Rev. FR. LAWRENCE MCCARTHY, Professor of Mathematics in St. Peter's College, Agra. Crown 8vo. 7s. 6d.

ALGEBRA.

Dalton.—RULES AND EXAMPLES IN ALGEBRA. By the Rev. T. DALTON, M.A., Assistant-Master of Eton College. Part I. New Edition. 18mo. 2s. Part II. 18mo. 2s. 6d.

* * *A Key to Part I. for Teachers only, 7s. 6d.*

Hall and Knight.—ELEMENTARY ALGEBRA FOR SCHOOLS. By H. S. HALL, M.A., formerly Scholar of Christ's College, Cambridge, Master of the Military and Engineering Side, Clifton College; and S. R. KNIGHT, B.A., formerly Scholar of

Trinity College, Cambridge, late Assistant-Master at Marlborough College. Second Edition, Revised and Corrected. Globe 8vo, bound in maroon coloured cloth, 3s. 6d.; with Answers, bound in green coloured cloth, 4s. 6d.

ALGEBRAICAL EXERCISES AND EXAMINATION PAPERS.

To accompany **ELEMENTARY ALGEBRA**. By the same Authors. Globe 8vo. 2s. 6d.

HIGHER ALGEBRA. A Sequel to "**ELEMENTARY ALGEBRA FOR SCHOOLS.**" By the same Authors. Crown 8vo. [Shortly.]

Jones and Cheyne.—**ALGEBRAICAL EXERCISES.** Progressively Arranged. By the Rev. C. A. JONES, M.A., and C. H. CHEYNE, M.A., F.R.A.S., Mathematical Masters of Westminster School. New Edition. 18mo. 2s. 6d.

Smith (Barnard).—**ARITHMETIC AND ALGEBRA**, in their Principles and Application; with numerous systematically arranged Examples taken from the Cambridge Examination Papers, with especial reference to the Ordinary Examination for the B.A. Degree. By the Rev. BARNARD SMITH, M.A., late Rector of Glaston, Rutland, and Fellow and Senior Bursar of St. Peter's College, Cambridge. New Edition, carefully Revised. Crown 8vo. 10s. 6d.

Smith (Charles).—Works by CHARLES SMITH, M.A., Fellow and Tutor of Sidney Sussex College, Cambridge.

ELEMENTARY ALGEBRA. Globe 8vo. 4s. 6d.

In this work the author has endeavoured to explain the principles of Algebra in as simple a manner as possible for the benefit of beginners, bestowing great care upon the explanations and proofs of the fundamental operations and rules.

ALGEBRA FOR SCHOOLS AND COLLEGES. Crown 8vo. [In the press.]

Todhunter.—Works by I. TODHUNTER, M.A., F.R.S., D.Sc., late of St. John's College, Cambridge.

"Mr. Todhunter is chiefly known to Students of Mathematics as the author of a series of admirable mathematical text-books, which possess the rare qualities of being clear in style and absolutely free from mistakes, typographical or other."—SATURDAY REVIEW.

ALGEBRA FOR BEGINNERS. With numerous Examples. New Edition. 18mo. 2s. 6d.

KEY TO ALGEBRA FOR BEGINNERS. Crown 8vo. 6s. 6d.

ALGEBRA. For the Use of Colleges and Schools. New Edition. Crown 8vo. 7s. 6d.

KEY TO ALGEBRA FOR THE USE OF COLLEGES AND SCHOOLS. Crown 8vo. 10s. 6d.

EUCLID, & ELEMENTARY GEOMETRY.

Constable.—**GEOMETRICAL EXERCISES FOR BEGINNERS.** By SAMUEL CONSTABLE. Crown 8vo. 3s. 6d.

Cuthbertson.—EUCLIDIAN GEOMETRY. By FRANCIS CUTHBERTSON, M.A., LL.D., Head Mathematical Master of the City of London School. Extra fcap. 8vo. 4s. 6d.

Dodgson.—Works by CHARLES L. DODGSON, M.A., Student and late Mathematical Lecturer of Christ Church, Oxford.

EUCLID. BOOKS I. AND II. Fourth Edition, with words substituted for the Algebraical Symbols used in the First Edition. Crown 8vo. 2s.

* * The text of this Edition has been ascertained, by counting the words, to be less than five-sevenths of that contained in the ordinary editions.

EUCLID AND HIS MODERN RIVALS. Second Edition. Crown 8vo. 6s.

Eagles.—CONSTRUCTIVE GEOMETRY OF PLANE CURVES. By T. H. EAGLES, M.A., Instructor in Geometrical Drawing, and Lecturer in Architecture at the Royal Indian Engineering College, Cooper's Hill. With numerous Examples. Crown 8vo. 12s.

Hall and Stevens.—A TEXT BOOK OF EUCLID'S ELEMENTS. Including alternative Proofs, together with additional Theorems and Exercises, classified and arranged. By H. S. HALL, M.A., formerly Scholar of Christ's College, Cambridge, and F. H. STEVENS, M.A., formerly Scholar of Queen's College, Oxford: Masters of the Military and Engineering Side, Clifton College. Globe 8vo. Part I., containing Books I. and II. 2s.

Halsted.—THE ELEMENTS OF GEOMETRY. By GEORGE BRUCE HALSTED, Professor of Pure and Applied Mathematics in the University of Texas. 8vo. 12s. 6d.

Kitchener.—A GEOMETRICAL NOTE-BOOK, containing Easy Problems in Geometrical Drawing preparatory to the Study of Geometry. For the Use of Schools. By F. E. KITCHENER, M.A., Head-Master of the Grammar School, Newcastle, Staffordshire. New Edition. 4to. 2s.

Mault.—NATURAL GEOMETRY: an Introduction to the Logical Study of Mathematics. For Schools and Technical Classes. With Explanatory Models, based upon the Tachymetrical works of Ed. Lagout. By A. MAULT. 18mo. 1s.
Models to Illustrate the above, in Box, 12s. 6d.

Snowball.—THE ELEMENTS OF PLANE AND SPHERICAL TRIGONOMETRY. By J. C. SNOWBALL, M.A. Fourteenth Edition. Crown 8vo. 7s. 6d.

Syllabus of Plane Geometry (corresponding to Euclid, Books I.—VI.). Prepared by the Association for the Improvement of Geometrical Teaching. New Edition. Crown 8vo. 1s.

Todhunter.—THE ELEMENTS OF EUCLID. For the Use of Colleges and Schools. By I. TODHUNTER, M.A., F.R.S., D.Sc., of St. John's College, Cambridge. New Edition. 18mo. 3s. 6d.
KEY TO EXERCISES IN EUCLID. Crown 8vo. 6s. 6d.

Wilson (J. M.).—ELEMENTARY GEOMETRY. BOOKS I.—V. Containing the Subjects of Euclid's first Six Books. Following the Syllabus of the Geometrical Association. By the Rev. J. M. WILSON, M.A., Head Master of Clifton College. New Edition. Extra fcap. 8vo. 4s. 6d.

TRIGONOMETRY.

Beasley.—AN ELEMENTARY TREATISE ON PLANE TRIGONOMETRY. With Examples. By R. D. BEASLEY, M.A. Ninth Edition, revised and enlarged. Crown 8vo. 3s. 6d.

Lock.—Works by Rev. J. B. LOCK, M.A., Senior Fellow, Assistant Tutor and Lecturer in Mathematics, of Gonville and Caius College, Cambridge; late Assistant-Master at Eton.

TRIGONOMETRY FOR BEGINNERS, as far as the Solution of Triangles. Globe 8vo. 2s. 6d.

ELEMENTARY TRIGONOMETRY. Fourth Edition (in this edition the chapter on logarithms has been carefully revised). Globe 8vo. 4s. 6d.

Mr. E. J. ROUTH writes:—"It is an able treatise. It takes the difficulties of the subject one at a time, and so leads the young student easily along."

HIGHER TRIGONOMETRY. Globe 8vo. 4s. 6d.

Both Parts complete in One Volume. Globe 8vo. 7s. 6d.

(See also under *Arithmetic*.)

M'Clelland and Preston.—A TREATISE ON SPHERICAL TRIGONOMETRY. With numerous Examples. By WILLIAM J. M'CLELLAND, Sch. B.A., Principal of the Incorporated Society's School, Santry, Dublin, and THOMAS PRESTON, Sch. B.A. In Two Parts. Crown 8vo. Part I. To the End of Solution of Triangles, 4s. 6d. Part II., 5s.

Todhunter.—Works by I. TODHUNTER, M.A., F.R.S., D.Sc., late of St. John's College, Cambridge.

TRIGONOMETRY FOR BEGINNERS. With numerous Examples. New Edition. 18mo. 2s. 6d.

KEY TO TRIGONOMETRY FOR BEGINNERS. Crown 8vo. 8s. 6d.

PLANE TRIGONOMETRY. For Schools and Colleges. New Edition. Crown 8vo. 5s.

KEY TO PLANE TRIGONOMETRY. Crown 8vo. 10s. 6d.

A TREATISE ON SPHERICAL TRIGONOMETRY. New Edition, enlarged. Crown 8vo. 4s. 6d.

(See also under *Arithmetic and Mensuration, Algebra, and Higher Mathematics*.)

HIGHER MATHEMATICS.

Airy.—Works by Sir G. B. AIRY, K.C.B., formerly Astronomer-Royal.
ELEMENTARY TREATISE ON PARTIAL DIFFERENTIAL EQUATIONS. Designed for the Use of Students in the Universities. With Diagrams. Second Edition. Crown 8vo. 5s. 6d.
ON THE ALGEBRAICAL AND NUMERICAL THEORY OF ERRORS OF OBSERVATIONS AND THE COMBINATION OF OBSERVATIONS. Second Edition, revised. Crown 8vo. 6s. 6d.

Alexander (T.).—**ELEMENTARY APPLIED MECHANICS.**
 Being the simpler and more practical Cases of Stress and Strain wrought out individually from first principles by means of Elementary Mathematics. By T. ALEXANDER, C.E., Professor of Civil Engineering in the Imperial College of Engineering, Tokyo, Japan. Part I. Crown 8vo. 4s. 6d.

Alexander and Thomson.—**ELEMENTARY APPLIED MECHANICS.** By THOMAS ALEXANDER, C.E., Professor of Engineering in the Imperial College of Engineering, Tokyo, Japan; and ARTHUR WATSON THOMSON, C.E., B.Sc., Professor of Engineering at the Royal College, Cirencester. Part II. TRANSVERSE STRESS. Crown 8vo. 10s. 6d.

Boole.—**THE CALCULUS OF FINITE DIFFERENCES.**
 By G. BOOLE, D.C.L., F.R.S., late Professor of Mathematics in the Queen's University, Ireland. Third Edition, revised by J. F. MOULTON. Crown 8vo. 10s. 6d.

Cambridge Senate-House Problems and Riders, with Solutions:—

1875—**PROBLEMS AND RIDERS.** By A. G. GREENHILL, M.A. Crown 8vo. 8s. 6d.

1878—**SOLUTIONS OF SENATE-HOUSE PROBLEMS.** By the Mathematical Moderators and Examiners. Edited by J. W. L. GLAISHER, M.A., Fellow of Trinity College, Cambridge. 12s.

Carll.—**A TREATISE ON THE CALCULUS OF VARIATIONS.** Arranged with the purpose of Introducing, as well as Illustrating, its Principles to the Reader by means of Problems, and Designed to present in all Important Particulars a Complete View of the Present State of the Science. By LEWIS BUFFETT CARLL, A.M. Demy 8vo. 21s.

Cheyne.—**AN ELEMENTARY TREATISE ON THE PLANETARY THEORY.** By C. H. H. CHEYNE, M.A., F.R.A.S. With a Collection of Problems. Third Edition. Edited by Rev. A. FREEMAN, M.A., F.R.A.S. Crown 8vo. 7s. 6d.

- Christie.**—A COLLECTION OF ELEMENTARY TEST-QUESTIONS IN PURE AND MIXED MATHEMATICS; with Answers and Appendices on Synthetic Division, and on the Solution of Numerical Equations by Horner's Method. By JAMES R. CHRISTIE, F.R.S., Royal Military Academy, Woolwich. Crown 8vo. 8s. 6d.
- Clausius.**—MECHANICAL THEORY OF HEAT. By R. CLAUDIUS. Translated by WALTER R. BROWNE, M.A., late Fellow of Trinity College, Cambridge. Crown 8vo. 10s. 6d.
- Clifford.**—THE ELEMENTS OF DYNAMIC. An Introduction to the Study of Motion and Rest in Solid and Fluid Bodies. By W. K. CLIFFORD, F.R.S., late Professor of Applied Mathematics and Mechanics at University College, London. Part I.—KINEMATIC. Crown 8vo. 7s. 6d.
- Cockshott and Walters.**—GEOMETRICAL CONICS. An Elementary Treatise. Drawn up in accordance with the Syllabus issued by the Society for the Improvement of Geometrical Teaching. By A. COCKSHOT, M.A., formerly Fellow and Assistant-Tutor of Trinity College, Cambridge, and Assistant-Master at Eton; and Rev. F. B. WALTERS, M.A., Fellow of Queens' College, Cambridge, and Principal of King William's College, Isle of Man. With Diagrams. Crown 8vo. *[In the press]*
- Cotterill.**—APPLIED MECHANICS: an Elementary General Introduction to the Theory of Structures and Machines. By JAMES H. COTTERILL, F.R.S., Associate Member of the Council of the Institution of Naval Architects, Associate Member of the Institution of Civil Engineers, Professor of Applied Mechanics in the Royal Naval College, Greenwich. Medium 8vo. 18s.
- Day (R. E.)**—ELECTRIC LIGHT ARITHMETIC. By R. E. DAY, M.A., Evening Lecturer in Experimental Physics at King's College, London. Pott 8vo. 2s.
- Drew.**—GEOMETRICAL TREATISE ON CONIC SECTIONS. By W. H. DREW, M.A., St. John's College, Cambridge. New Edition, enlarged. Crown 8vo. 5s.
- Dyer.**—EXERCISES IN ANALYTICAL GEOMETRY. Compiled and arranged by J. M. DYER, M.A., Senior Mathematical Master in the Classical Department of Cheltenham College. With Illustrations. Crown 8vo. 4s. 6d.
- Eagles.**—CONSTRUCTIVE GEOMETRY OF PLANE CURVES. By T. H. EAGLES, M.A., Instructor in Geometrical Drawing, and Lecturer in Architecture at the Royal Indian Engineering College, Cooper's Hill. With numerous Examples. Crown 8vo. 12s.

- Edgar (J. H.) and Pritchard (G. S.).**—NOTE-BOOK ON PRACTICAL SOLID OR DESCRIPTIVE GEOMETRY. Containing Problems with help for Solutions. By J. H. EDGAR, M.A., Lecturer on Mechanical Drawing at the Royal School of Mines, and G. S. PRITCHARD. Fourth Edition, revised by ARTHUR MEEZE. Globe 8vo. 4s. 6d.
- Edwards.**—THE DIFFERENTIAL CALCULUS. With Applications and numerous Examples. An Elementary Treatise by JOSEPH EDWARDS, M.A., formerly Fellow of Sidney Sussex College, Cambridge. Crown 8vo. 10s. 6d.
- Ferrers.**—Works by the Rev. N. M. FERRERS, M.A., Master of Gonville and Caius College, Cambridge.
AN ELEMENTARY TREATISE ON TRILINEAR CO-ORDINATES, the Method of Reciprocal Polars, and the Theory of Projectors. New Edition, revised. Crown 8vo. 6s. 6d.
AN ELEMENTARY TREATISE ON SPHERICAL HARMONICS, AND SUBJECTS CONNECTED WITH THEM. Crown 8vo. 7s. 6d.
- Forsyth.**—A TREATISE ON DIFFERENTIAL EQUATIONS. By ANDREW RUSSELL FORSYTH, M.A., F.R.S., Fellow and Assistant Tutor of Trinity College, Cambridge. 8vo. 14s.
- Frost.**—Works by PERCIVAL FROST, M.A., D.Sc., formerly Fellow of St. John's College, Cambridge; Mathematical Lecturer at King's College.
AN ELEMENTARY TREATISE ON CURVE TRACING. By PERCIVAL FROST, M.A. 8vo. 12s.
SOLID GEOMETRY. Third Edition. Demy 8vo. 16s.
HINTS FOR THE SOLUTION OF PROBLEMS in the Third Edition of SOLID GEOMETRY. 8vo. 8s. 6d.
- Greaves.**—A TREATISE ON ELEMENTARY STATICS. By JOHN GREAVES, M.A., Fellow and Mathematical Lecturer of Christ's College, Cambridge. Crown 8vo. 6s. 6d.
- Greenhill.**—DIFFERENTIAL AND INTEGRAL CALCULUS. With Applications. By A. G. GREENHILL, M.A., Professor of Mathematics to the Senior Class of Artillery Officers, Woolwich, and Examiner in Mathematics to the University of London. Crown 8vo. 7s. 6d.
- Hemming.**—AN ELEMENTARY TREATISE ON THE DIFFERENTIAL AND INTEGRAL CALCULUS, for the Use of Colleges and Schools. By G. W. HEMMING, M.A., Fellow of St. John's College, Cambridge. Second Edition, with Corrections and Additions. 8vo. 9s.
- Ibbetson.**—THE MATHEMATICAL THEORY OF PERFECTLY ELASTIC SOLIDS, with a short account of Viscous Fluids. An Elementary Treatise. By WILLIAM JOHN IBBETSON, B.A., F.R.A.S., Senior Scholar of Clare College, Cambridge. 8vo. *[In the press.]*

- Jellett (John H.).**—A TREATISE ON THE THEORY OF FRICTION. By JOHN H. JELLETT, B.D., Provost of Trinity College, Dublin; President of the Royal Irish Academy. 8vo. 8s. 6d.
- Johnson.**—Works by WILLIAM WOOLSEY JOHNSON, Professor of Mathematics at the U.S. Naval Academy, Annapolis, Maryland.
INTEGRAL CALCULUS, an Elementary Treatise on the; Founded on the Method of Rates or Fluxions. Demy 8vo. 8s.
CURVE TRACING IN CARTESIAN CO-ORDINATES. Crown 8vo. 4s. 6d.
- Jones.**—EXAMPLES IN PHYSICS. By D. E. JONES, B.Sc., Lecturer in Physics in University College, Aberystwyth. Fcap. 8vo. [In preparation.]
- Kelland and Tait.**—INTRODUCTION TO QUATERNIONS, with numerous examples. By P. KELLAND, M.A., F.R.S., and P. G. TAIT, M.A., Professors in the Department of Mathematics in the University of Edinburgh. Second Edition. Crown 8vo. 7s. 6d.
- Kempe.**—HOW TO DRAW A STRAIGHT LINE: a Lecture on Linkages. By A. B. KEMPE. With Illustrations. Crown 8vo. 1s. 6d. (*Nature Series.*)
- Kennedy.**—THE MECHANICS OF MACHINERY. By A. B. W. KENNEDY, M.Inst.C.E., Professor of Engineering and Mechanical Technology in University College, London. With Illustrations. Crown 8vo. 12s. 6d.
- Knox.**—DIFFERENTIAL CALCULUS FOR BEGINNERS. By ALEXANDER KNOX. Fcap. 8vo. 3s. 6d.
- Lock.**—DYNAMICS FOR BEGINNERS. By the Rev. J. B. LOCK, M.A., Author of "Trigonometry," "Arithmetic for Schools," &c. Globe 8vo. (See also under ARITHMETIC and TRIGONOMETRY.) [In the press.]
- Lupton.**—CHEMICAL ARITHMETIC. With 1,200 Examples. By SYDNEY LUPTON, M.A., F.C.S., F.I.C., formerly Assistant Master in Harrow School. Second Edition. Fcap. 8vo. 4s. 6d.
- Macfarlane.**—PHYSICAL ARITHMETIC. By ALEXANDER MACFARLANE, M.A., D.Sc., F.R.S.E., Examiner in Mathematics to the University of Edinburgh. Crown 8vo. 7s. 6d.
- MacGregor.**—KINEMATICS AND DYNAMICS. An Elementary Treatise. By J. G. MACGREGOR, Professor of Physics in Dalhousie College, Halifax, Nova Scotia. Cr. 8vo. [In the press.]
- Merriman.**—A TEXT BOOK OF THE METHOD OF LEAST SQUARES. By MANSFIELD MERRIMAN, Professor of Civil Engineering at Lehigh University, Member of the American Philosophical Society, American Association for the Advancement of Science, &c. Demy 8vo. 8s. 6d.

Millar.—ELEMENTS OF DESCRIPTIVE GEOMETRY. By J.B. MILLAR, C.E., Assistant Lecturer in Engineering in Owens College, Manchester. Crown 8vo. 6s.

Milne.—WEEKLY PROBLEM PAPERS. With Notes intended for the use of students preparing for Mathematical Scholarships, and for the Junior Members of the Universities who are reading for Mathematical Honours. By the Rev. JOHN J. MILNE, M.A., formerly Second Master of Heversham Grammar School. Pott 8vo. 4s. 6d.

SOLUTIONS TO WEEKLY PROBLEM PAPERS. By the same Author. Crown 8vo. 10s. 6d.

COMPANION TO "WEEKLY PROBLEM PAPERS." By the same Author. Crown 8vo. [*Nearly ready.*]

Muir.—A TREATISE ON THE THEORY OF DETERMINANTS. With graduated sets of Examples. For use in Colleges and Schools. By THOS. MUIR, M.A., F.R.S.E., Mathematical Master in the High School of Glasgow. Crown 8vo. 7s. 6d.

Parkinson.—AN ELEMENTARY TREATISE ON MECHANICS. For the Use of the Junior Classes at the University and the Higher Classes in Schools. By S. PARKINSON, D.D., F.R.S., Tutor and Praelector of St. John's College, Cambridge. With a Collection of Examples. Sixth Edition, revised. Crown 8vo. 9s. 6d.

Pirie.—LESSONS ON RIGID DYNAMICS. By the Rev. G. PIRIE, M.A., late Fellow and Tutor of Queen's College, Cambridge; Professor of Mathematics in the University of Aberdeen. Crown 8vo. 6s.

Puckle.—AN ELEMENTARY TREATISE ON CONIC SECTIONS AND ALGEBRAIC GEOMETRY. With Numerous Examples and Hints for their Solution; especially designed for the Use of Beginners. By G. H. PUCKLE, M.A. Fifth Edition, revised and enlarged. Crown 8vo. 7s. 6d.

Reuleaux.—THE KINEMATICS OF MACHINERY. Outlines of a Theory of Machines. By Professor F. REULEAUX. Translated and Edited by Professor A. B. W. KENNEDY, C.E. With 450 Illustrations. Medium 8vo. 21s.

Rice and Johnson.—DIFFERENTIAL CALCULUS, an Elementary Treatise on the; Founded on the Method of Rates or Fluxions. By JOHN MINOT RICE, Professor of Mathematics in the United States Navy, and WILLIAM WOOLSEY JOHNSON, Professor of Mathematics at the United States Naval Academy. Third Edition, Revised and Corrected. Demy 8vo. 16s. Abridged Edition, 8s.

Robinson.—TREATISE ON MARINE SURVEYING. Prepared for the use of younger Naval Officers. With Questions for Examinations and Exercises principally from the Papers of the Royal Naval College. With the results. By Rev. JOHN L. ROBINSON, Chaplain and Instructor in the Royal Naval College, Greenwich. With Illustrations. Crown 8vo. 7s. 6d.

CONTENTS.—Symbols used in Charts and Surveying—The Construction and Use of Scales—Laying off Angles—Fixing Positions by Angles—Charts and Chart-Drawing—Instruments and Observing—Base Lines—Triangulation—Levelling—Tides and Tidal Observations—Soundings—Chronometers—Meridian Distances—Method of Plotting a Survey—Miscellaneous Exercises—Index.

Routh.—Works by EDWARD JOHN ROUTH, D.Sc., LL.D., F.R.S., Fellow of the University of London, Hon. Fellow of St. Peter's College, Cambridge.

A TREATISE ON THE DYNAMICS OF THE SYSTEM OF RIGID BODIES. With numerous Examples. Fourth and enlarged Edition. Two Vols. 8vo. Vol. I.—Elementary Parts. 14s. Vol. II.—The Advanced Parts. 14s.

STABILITY OF A GIVEN STATE OF MOTION, PARTICULARLY STEADY MOTION. Adams' Prize Essay for 1877. 8vo. 8s. 6d.

Smith (C.).—Works by CHARLES SMITH, M.A., Fellow and Tutor of Sidney Sussex College, Cambridge.

CONIC SECTIONS. Fourth Edition. Crown 8vo. 7s. 6d.

AN ELEMENTARY TREATISE ON SOLID GEOMETRY. Second Edition. Crown 8vo. 9s. 6d. (See also under *Algebra*.)

Tait and Steele.—A TREATISE ON DYNAMICS OF A PARTICLE. With numerous Examples. By Professor TAIT and Mr. STEELE. Fifth Edition, revised. Crown 8vo. 12s.

Thomson.—A TREATISE ON THE MOTION OF VORTEX RINGS. An Essay to which the Adams Prize was adjudged in 1882 in the University of Cambridge. By J. J. THOMSON, Fellow of Trinity College, Cambridge, and Professor of Experimental Physics in the University. With Diagrams. 8vo. 6s.

Todhunter.—Works by I. TODHUNTER, M.A., F.R.S., D.Sc., late of St. John's College, Cambridge.

"Mr. Todhunter is chiefly known to students of Mathematics as the author of a series of admirable mathematical text-books, which possess the rare qualities of being clear in style and absolutely free from mistakes, typographical and other."—SATURDAY REVIEW.

MECHANICS FOR BEGINNERS. With numerous Examples. New Edition. 18mo. 4s. 6d.

KEY TO MECHANICS FOR BEGINNERS. Crown 8vo. 6s. 6d.

AN ELEMENTARY TREATISE ON THE THEORY OF EQUATIONS. New Edition, revised. Crown 8vo. 7s. 6d.

PLANE CO-ORDINATE GEOMETRY, as applied to the Straight Line and the Conic Sections. With numerous Examples. New Edition, revised and enlarged. Crown 8vo. 7s. 6d.

Todhunter.—KEY TO CONIC SECTIONS. By C. W. BOURNE, M.A. Head Master of the College, Inverness. Crown 8vo. [In the press.]

A TREATISE ON THE DIFFERENTIAL CALCULUS. With numerous Examples. New Edition. Crown 8vo. 10s. 6d.

A TREATISE ON THE INTEGRAL CALCULUS AND ITS APPLICATIONS. With numerous Examples. New Edition, revised and enlarged. Crown 8vo. 10s. 6d.

EXAMPLES OF ANALYTICAL GEOMETRY OF THREE DIMENSIONS. New Edition, revised. Crown 8vo. 4s.

A TREATISE ON ANALYTICAL STATICS. New Edition, revised by Professor J. D. EVERETT, F.R.S. Crown 8vo. [In the press.]

A HISTORY OF THE MATHEMATICAL THEORY OF PROBABILITY, from the time of Pascal to that of Laplace. 8vo. 18s.

A HISTORY OF THE MATHEMATICAL THEORIES OF ATTRACTION, AND THE FIGURE OF THE EARTH, from the time of Newton to that of Laplace. 2 vols. 8vo. 24s.

AN ELEMENTARY TREATISE ON LAPLACE'S, LAME'S, AND BESSEL'S FUNCTIONS. Crown 8vo. 10s. 6d.

(See also under *Arithmetic and Mensuration, Algebra, and Trigonometry.*)

Wilson (J. M.).—SOLID GEOMETRY AND CONIC SECTIONS. With Appendices on Transversals and Harmonic Division. For the Use of Schools. By Rev. J. M. WILSON, M.A. Head Master of Clifton College. New Edition. Extra fcap. 8vo. 3s. 6d.

Woolwich Mathematical Papers, for Admission into the Royal Military Academy, Woolwich, 1880—1884 inclusive. Crown 8vo. 3s. 6d.

Wolstenholme.—MATHEMATICAL PROBLEMS, on Subjects included in the First and Second Divisions of the Schedule of subjects for the Cambridge Mathematical Tripos Examination. Devised and arranged by JOSEPH WOLSTENHOLME, D.Sc., late Fellow of Christ's College, sometime Fellow of St. John's College, and Professor of Mathematics in the Royal Indian Engineering College. New Edition, greatly enlarged. 8vo. 18s.

EXAMPLES FOR PRACTICE IN THE USE OF SEVEN-FIGURE LOGARITHMS. By the same Author. [In preparation.]

SCIENCE.

(1) Natural Philosophy, (2) Astronomy, (3) Chemistry, (4) Biology, (5) Medicine, (6) Anthropology, (7) Physical Geography and Geology, (8) Agriculture.

NATURAL PHILOSOPHY.

Airy.—Works by Sir G. B. AIRY, K.C.B., formerly Astronomer-Royal.

ON SOUND AND ATMOSPHERIC VIBRATIONS. With the Mathematical Elements of Music. Designed for the Use of Students in the University. Second Edition, revised and enlarged. Crown 8vo 9s

A TREATISE ON MAGNETISM. Designed for the Use of Students in the University. Crown 8vo. 9s. 6d.

GRAVITATION: an Elementary Explanation of the Principal Perturbations in the Solar System. Second Edition. Crown 8vo. 7s. 6d.

Alexander (T.).—ELEMENTARY APPLIED MECHANICS. Being the simpler and more practical Cases of Stress and Strain wrought out individually from first principles by means of Elementary Mathematics. By T. ALEXANDER, C.E., Professor of Civil Engineering in the Imperial College of Engineering, Tokei, Japan. Crown 8vo. Part I. 4s. 6d.

Alexander — Thomson. — ELEMENTARY APPLIED MECHANICS. By THOMAS ALEXANDER, C.E., Professor of Engineering in the Imperial College of Engineering, Tokei, Japan; and ARTHUR WATSON THOMSON, C.E., B.Sc., Professor of Engineering at the Royal College, Cirencester. Part II. TRANSVERSE STRESS; upwards of 150 Diagrams, and 200 Examples carefully worked out; new and complete method for finding, at every point of a beam, the amount of the greatest bending moment and shearing force during the transit of any set of loads fixed relatively to one another—*e.g.*, the wheels of a locomotive; continuous beams, &c., &c. Crown 8vo. 10s. 6d.

Ball (R. S.).—EXPERIMENTAL MECHANICS. A Course of Lectures delivered at the Royal College of Science for Ireland. By Sir R. S. BALL, M.A., Astronomer Royal for Ireland. Cheaper Issue. Royal 8vo. 10s. 6d.

Bottomley.—FOUR FIGURE MATHEMATICAL TABLES FOR PHYSICAL CALCULATION. By J. T. BOTTOMLEY, M.A., F.R.S.E., Demonstrator in Experimental Physics in the University of Glasgow. 8vo. [In the press.]

Chisholm.—THE SCIENCE OF WEIGHING AND MEASURING, AND THE STANDARDS OF MEASURE AND WEIGHT. By H. W. CHISHOLM, Warden of the Standards. With numerous Illustrations. Crown 8vo. 4s. 6d. (*Nature Series*).

Clausius.—MECHANICAL THEORY OF HEAT. By R. CLAUDIUS. Translated by WALTER R. BROWNE, M.A., late Fellow of Trinity College, Cambridge. Crown 8vo. 10s. 6d.

Cotterill.—APPLIED MECHANICS: an Elementary General Introduction to the Theory of Structures and Machines. By JAMES H. COTTERILL, F.R.S., Associate Member of the Council of the Institution of Naval Architects, Associate Member of the Institution of Civil Engineers, Professor of Applied Mechanics in the Royal Naval College, Greenwich. Medium 8vo. 18s.

Cumming.—AN INTRODUCTION TO THE THEORY OF ELECTRICITY. By LINNÆUS CUMMING, M.A., one of the Masters of Rugby School. With Illustrations. Crown 8vo. 8s. 6d.

Daniell.—A TEXT-BOOK OF THE PRINCIPLES OF PHYSICS. By ALFRED DANIELL, M.A., LL.B., D.Sc., F.R.S.E., late Lecturer on Physics in the School of Medicine, Edinburgh. With Illustrations. Second Edition. Revised and Enlarged. Medium 8vo. 21s.

Day.—ELECTRIC LIGHT ARITHMETIC. By R. E. DAY, M.A., Evening Lecturer in Experimental Physics at King's College, London. Pott 8vo. 2s.

Everett.—UNITS AND PHYSICAL CONSTANTS. By J. D. EVERETT, M.A., D.C.L., F.R.S., F.R.S.E., Professor of Natural Philosophy, Queen's College, Belfast. Second Edition. Extra fcap. 8vo. 5s.

Gray.—ABSOLUTE MEASUREMENTS IN ELECTRICITY AND MAGNETISM. By ANDREW GRAY, M.A., F.R.S.E., Professor of Physics in the University College of North Wales. Crown 8vo. [New Edition in the press.]

Grove.—A DICTIONARY OF MUSIC AND MUSICIANS. (A.D. 1450—1886). By Eminent Writers, English and Foreign. Edited by Sir GEORGE GROVE, D.C.L., Director of the Royal College of Music, &c. Demy 8vo.

Vols. I., II., and III. Price 21s. each.

Vol. I. A to IMPROMPTU. Vol. II. IMPROPERIA TO PLAIN SONG. Vol. III. PLANCHE TO SUMER IS ICUMEN IN. Demy 8vo. cloth, with Illustrations in Music Type and Woodcut. Also published in Parts. Parts I. to XIV., Parts XIX—XXI., price 3s. 6d. each. Parts XV., XVI., price 7s. Parts XVII., XVIII., price 7s.

"Dr. Grove's Dictionary will be a boon to every intelligent lover of music."—SATURDAY REVIEW.

Huxley.—INTRODUCTORY PRIMER OF SCIENCE. By T. H. HUXLEY, F.R.S., &c. 18mo. 1s.

- Ibbetson.**—THE MATHEMATICAL THEORY OF PERFECTLY ELASTIC SOLIDS, with a Short Account of Viscous Fluids. An Elementary Treatise. By WILLIAM JOHN IBBETSON, B.A., F.R.A.S., Senior Scholar of Clare College, Cambridge. 8vo. *[In the press.]*
- Jones.**—EXAMPLES IN PHYSICS. By D. E. JONES, B.Sc. Lecturer in Physics in University College, Aberystwyth. Fcap. 8vo. *[In preparation.]*
- Kempe.**—HOW TO DRAW A STRAIGHT LINE; a Lecture on Linkages. By A. B. KEMPE. With Illustrations. Crown 8vo. 1s. 6d. (*Nature Series.*)
- Kennedy.**—THE MECHANICS OF MACHINERY. By A. B. W. KENNEDY, M.Inst.C.E., Professor of Engineering and Mechanical Technology in University College, London. With numerous Illustrations. Crown 8vo. 12s. 6d.
- Lang.**—EXPERIMENTAL PHYSICS. By P. R. SCOTT LANG, M.A., Professor of Mathematics in the University of St. Andrews. With Illustrations. Crown 8vo. *[In the press.]*
- Lupton.**—NUMERICAL TABLES AND CONSTANTS IN ELEMENTARY SCIENCE. By SYDNEY LUPTON, M.A., F.C.S., F.I.C., Assistant Master at Harrow School. Extra fcap. 8vo. 2s. 6d.
- Macfarlane.**—PHYSICAL ARITHMETIC. By ALEXANDER MACFARLANE, D.Sc., Examiner in Mathematics in the University of Edinburgh. Crown 8vo. 7s. 6d.
- Macgregor.**—KINEMATICS AND DYNAMICS. An Elementary Treatise. By J. G. MACGREGOR, M.A., Professor of Physics in Dalhousie College, Halifax, Nova Scotia. With Illustrations. Crown 8vo. *[In the press.]*
- Mayer.**—SOUND: a Series of Simple, Entertaining, and Inexpensive Experiments in the Phenomena of Sound, for the Use of Students of every age. By A. M. MAYER, Professor of Physics in the Stevens Institute of Technology, &c. With numerous Illustrations. Crown 8vo. 3s. 6d. (*Nature Series.*)
- Mayer and Barnard.**—LIGHT: a Series of Simple, Entertaining, and Inexpensive Experiments in the Phenomena of Light, for the Use of Students of every age. By A. M. MAYER and C. BARNARD. With numerous Illustrations. Crown 8vo. 2s. 6d. (*Nature Series.*)
- Newton.**—PRINCIPIA. Edited by Professor Sir W. THOMSON and Professor BLACKBURNE. 4to, cloth. 31s. 6d.
- THE FIRST THREE SECTIONS OF NEWTON'S PRINCIPIA. With Notes and Illustrations. Also a Collection of Problems, principally intended as Examples of Newton's Methods. By PERCIVAL FROST, M.A. Third Edition. 8vo. 12s.

- Parkinson.**—A TREATISE ON OPTICS. By S. PARKINSON, D.D., F.R.S., Tutor and Prælector of St. John's College, Cambridge. Fourth Edition, revised and enlarged. Crown 8vo. 10s. 6d.
- Perry.**—STEAM. AN ELEMENTARY TREATISE. By JOHN PERRY, C.E., Whitworth Scholar, Fellow of the Chemical Society, Professor of Mechanical Engineering and Applied Mechanics at the Technical College, Finsbury. With numerous Woodcuts and Numerical Examples and Exercises. 18mo. 4s. 6d.
- Ramsay.**—EXPERIMENTAL PROOFS OF CHEMICAL THEORY FOR BEGINNERS. By WILLIAM RAMSAY, Ph.D., Professor of Chemistry in University College, Bristol. Pott 8vo. 2s. 6d.
- Rayleigh.**—THE THEORY OF SOUND. By LORD RAYLEIGH, M.A., F.R.S., formerly Fellow of Trinity College, Cambridge, 8vo. Vol. I. 12s. 6d. Vol. II. 12s. 6d. [*Vol. III. in the press.*]
- Reuleaux.**—THE KINEMATICS OF MACHINERY. Outlines of a Theory of Machines. By Professor F. REULEAUX. Translated and Edited by Professor A. B. W. KENNEDY, C.E. With 450 Illustrations. Medium 8vo. 21s.
- Roscoe and Schuster.**—SPECTRUM ANALYSIS. Lectures delivered in 1868 before the Society of Apothecaries of London. By Sir HENRY E. ROSCOE, LL.D., F.R.S., formerly Professor of Chemistry in the Owens College, Victoria University, Manchester. Fourth Edition, revised and considerably enlarged by the Author and by ARTHUR SCHUSTER, F.R.S., Ph.D., Professor of Applied Mathematics in the Owens College, Victoria University. With Appendices, numerous Illustrations, and Plates. Medium 8vo. 21s.
- Shann.**—AN ELEMENTARY TREATISE ON HEAT, IN RELATION TO STEAM AND THE STEAM-ENGINE. By G. SHANN, M.A. With Illustrations. Crown 8vo. 4s. 6d.
- Spottiswoode.**—POLARISATION OF LIGHT. By the late W. SPOTTISWOODE, F.R.S. With many Illustrations. New Edition. Crown 8vo. 3s. 6d. (*Nature Series.*)
- Stewart (Balfour).**—Works by BALFOUR STEWART, F.R.S., Professor of Natural Philosophy in the Owens College, Victoria University, Manchester.
- PRIMER OF PHYSICS. With numerous Illustrations. New Edition, with Questions. 18mo. 1s. (*Science Primers.*)
- LESSONS IN ELEMENTARY PHYSICS. With numerous Illustrations and Chromolitho of the Spectra of the Sun, Stars, and Nebulæ. New Edition. Fcap. 8vo. 4s. 6d.
- QUESTIONS ON BALFOUR STEWART'S ELEMENTARY LESSONS IN PHYSICS. By Prof. THOMAS H. CORN, Owens College, Manchester. Fcap. 8vo. 2s.

Stewart and Gee.—ELEMENTARY PRACTICAL PHYSICS, LESSONS IN. By Professor BALFOUR STEWART, F.R.S., and W. HALDANE GEE, B.Sc. Crown 8vo.

Part I.—GENERAL PHYSICAL PROCESSES. 6s.

Part II.—ELECTRICITY AND MAGNETISM. [*Nearly ready.*]

Part III.—OPTICS, HEAT, AND SOUND. [*In preparation.*]

A SCHOOL COURSE OF PRACTICAL PHYSICS. By the same Authors.

Part I.—ELECTRICITY AND MAGNETISM. [*In the press.*]

Stokes.—ON LIGHT. Being the Burnett Lectures, delivered in Aberdeen in 1883-1884. By GEORGE GABRIEL STOKES, M.A., P.R.S., &c., Fellow of Pembroke College, and Lucasian Professor of Mathematics in the University of Cambridge. First Course. ON THE NATURE OF LIGHT.—Second Course. ON LIGHT AS A MEANS OF INVESTIGATION. Crown 8vo. 2s. 6d. each.

[*Third Course in the press.*]

Stone.—AN ELEMENTARY TREATISE ON SOUND. By W. H. STONE, M.D. With Illustrations. 18mo. 3s. 6d.

Tait.—HEAT. By P. G. TAIT, M.A., Sec. R.S.E., formerly Fellow of St. Peter's College, Cambridge, Professor of Natural Philosophy in the University of Edinburgh. Crown 8vo. 6s.

Thompson.—ELEMENTARY LESSONS IN ELECTRICITY AND MAGNETISM. By SILVANUS P. THOMPSON, Principal and Professor of Physics in the Technical College, Finsbury. With Illustrations. New Edition. Fcap. 8vo. 4s. 6d.

Thomson.—ELECTROSTATICS AND MAGNETISM, REPRINTS OF PAPERS ON. By Sir WILLIAM THOMSON, D.C.L., LL.D., F.R.S., F.R.S.E., Fellow of St. Peter's College, Cambridge, and Professor of Natural Philosophy in the University of Glasgow. Second Edition. Medium 8vo. 18s.

THE MOTION OF VORTEX RINGS, A TREATISE ON. An Essay to which the Adams Prize was adjudged in 1882 in the University of Cambridge. By J. J. THOMSON, Fellow of Trinity College, Cambridge, and Professor of Experimental Physics in the University. With Diagrams. 8vo. 6s.

Todhunter.—NATURAL PHILOSOPHY FOR BEGINNERS. By I. TODHUNTER, M.A., F.R.S., D.Sc.

Part I. The Properties of Solid and Fluid Bodies. 18mo. 3s. 6d.

Part II. Sound, Light, and Heat. 18mo. 3s. 6d.

Turner.—HEAT AND ELECTRICITY, A COLLECTION OF EXAMPLES ON. By H. H. TURNER, B.A., Fellow of Trinity College, Cambridge. Crown 8vo. 2s. 6d.

Wright (Lewis).—LIGHT; A COURSE OF EXPERIMENTAL OPTICS, CHIEFLY WITH THE LANTERN. By LEWIS WRIGHT. With nearly 200 Engravings and Coloured Plates. Crown 8vo. 7s. 6d.

ASTRONOMY.

Airy.—POPULAR ASTRONOMY. With Illustrations by Sir G. B. AIRY, K.C.B., formerly Astronomer-Royal. New Edition. 18mo. 4s. 6d.

Forbes.—TRANSIT OF VENUS. By G. FORBES, M.A., Professor of Natural Philosophy in the Andersonian University, Glasgow. Illustrated. Crown 8vo. 3s. 6d. (*Nature Series.*)

Godfray.—Works by HUGH GODFRAY, M.A., Mathematical Lecturer at Pembroke College, Cambridge.

A TREATISE ON ASTRONOMY, for the Use of Colleges and Schools. Fourth Edition. 8vo. 12s. 6d.

AN ELEMENTARY TREATISE ON THE LUNAR THEORY, with a Brief Sketch of the Problem up to the time of Newton. Second Edition, revised. Crown 8vo. 5s. 6d.

Lockyer.—Works by J. NORMAN LOCKYER, F.R.S.

PRIMER OF ASTRONOMY. With numerous Illustrations. New Edition. 18mo. 1s. (*Science Primers.*)

ELEMENTARY LESSONS IN ASTRONOMY. With Coloured Diagram of the Spectra of the Sun, Stars, and Nebulæ, and numerous Illustrations. New Edition. Fcap. 8vo. 5s. 6d.

QUESTIONS ON LOCKYER'S ELEMENTARY LESSONS IN ASTRONOMY. For the Use of Schools. By JOHN FORBES-ROBERTSON. 18mo, cloth limp 1s. 6d.

THE CHEMISTRY OF THE SUN. With Illust. Demy 8vo. 14s.

Newcomb.—POPULAR ASTRONOMY. By S. NEWCOMB, LL.D., Professor U.S. Naval Observatory. With 112 Illustrations and 5 Maps of the Stars. Second Edition, revised. 8vo. 18s.

"It is unlike anything else of its kind, and will be of more use in circulating a knowledge of Astronomy than nine-tenths of the books which have appeared on the subject of late years."—SATURDAY REVIEW.

CHEMISTRY.

Armstrong.—A MANUAL OF INORGANIC CHEMISTRY. By HENRY ARMSTRONG, Ph.D., F.R.S., Professor of Chemistry in the City and Guilds of London Technical Institute. Crown 8vo. [*In preparation.*]

Cohen.—THE OWENS COLLEGE JUNIOR COURSE OF PRACTICAL ORGANIC CHEMISTRY. By JULIUS B. COHEN, Ph.D., Assistant Lecturer on Chemistry in the Owens College, Manchester. With a Preface by SIR HENRY ROSCOE. Fcap. 8vo. [*In the press.*]

Cooke.—ELEMENTS OF CHEMICAL PHYSICS. By JOSIAH P. COOKE, Junr., Erving Professor of Chemistry and Mineralogy in Harvard University. Fourth Edition. Royal 8vo. 21s.

Fleischer.—A SYSTEM OF VOLUMETRIC ANALYSIS. Translated, with Notes and Additions, from the Second German Edition by M. M. PATTISON MUIR, F.R.S.E. With Illustrations. Crown 8vo. 7s. 6d.

Frankland.—AGRICULTURAL CHEMICAL ANALYSIS, A Handbook of. By PERCY FARADAY FRANKLAND, Ph.D., B.Sc., F.C.S., Associate of the Royal School of Mines, and Demonstrator of Practical and Agricultural Chemistry in the Normal School of Science and Royal School of Mines, South Kensington Museum. Founded upon *Leitfaden für die Agriculture Chemische Analyse*, von Dr. F. KROCKER. Crown 8vo. 7s. 6d.

Jones.—Works by FRANCIS JONES, F.R.S.E., F.C.S., Chemical Master in the Grammar School, Manchester.

THE OWENS COLLEGE JUNIOR COURSE OF PRACTICAL CHEMISTRY. With Preface by Sir HENRY ROSCOE, F.R.S., and Illustrations. New Edition. 18mo. 2s. 6d.

QUESTIONS ON CHEMISTRY. A Series of Problems and Exercises in Inorganic and Organic Chemistry. Fcap. 8vo. 3s.

Landauer.—BLOWPIPE ANALYSIS. By J. LANDAUER. Authorised English Edition by J. TAYLOR and W. E. KAY, of Owens College, Manchester. Extra fcap. 8vo. 4s. 6d.

Lupton.—ELEMENTARY CHEMICAL ARITHMETIC. With 1,200 Problems. By SYDNEY LUPTON, M.A., F.C.S., F.I.C., formerly Assistant-Master at Harrow. Second Edition, Revised and Abridged. Fcap. 8vo. 4s. 6d.

Muir.—PRACTICAL CHEMISTRY FOR MEDICAL STUDENTS. Specially arranged for the first M.B. Course. By M. M. PATTISON MUIR, F.R.S.E. Fcap. 8vo. 1s. 6d.

Muir and Wilson.—THE ELEMENTS OF THERMAL CHEMISTRY. By M. M. PATTISON MUIR, M.A., F.R.S.E., Fellow and Prælector of Chemistry in Gonville and Caius College, Cambridge; Assisted by DAVID MUIR WILSON. 8vo. 12s. 6d.

Remsen.—Works by IRA REMSEN, Professor of Chemistry in the Johns Hopkins University.

COMPOUNDS OF CARBON; or, Organic Chemistry, an Introduction to the Study of. Crown 8vo. 6s. 6d.

AN INTRODUCTION TO THE STUDY OF CHEMISTRY (INORGANIC CHEMISTRY). Crown 8vo. 6s. 6d.

Roscoe.—Works by Sir HENRY E. ROSCOE, F.R.S., formerly Professor of Chemistry in the Victoria University the Owens College, Manchester.

PRIMER OF CHEMISTRY. With numerous Illustrations. New Edition. With Questions. 18mo. 1s. (*Science Primers*.)

LESSONS IN ELEMENTARY CHEMISTRY, INORGANIC AND ORGANIC. With numerous Illustrations and Chromolitho of the Solar Spectrum, and of the Alkalies and Alkaline Earths. New Edition. Fcap. 8vo. 4s. 6d.

(See under THORPE.)

Roscoe and Schorlemmer.—INORGANIC AND ORGANIC CHEMISTRY. A Complete Treatise on Inorganic and Organic Chemistry. By Sir HENRY E. ROSCOE, F.R.S., and Profes. or C. SCHORLEMMER, F.R.S. With numerous Illustrations. Medium 8vo.

Vols. I. and II.—INORGANIC CHEMISTRY.

Vol. I.—The Non-Metallic Elements. 21s. Vol. II. Part I.—Metals. 18s. Vol. II. Part II.—Metals. 18s.

Vol. III.—ORGANIC CHEMISTRY.

THE CHEMISTRY OF THE HYDROCARBONS and their Derivatives, or ORGANIC CHEMISTRY. With numerous Illustrations. Three Parts. Parts I. and II. 21s. each. Part III. 18s.

Schorlemmer.—A MANUAL OF THE CHEMISTRY OF THE CARBON COMPOUNDS, OR ORGANIC CHEMISTRY. By C. SCHORLEMMER, F.R.S., Professor of Chemistry in the Victoria University the Owens College, Manchester. With Illustrations. 8vo. 14s.

Thorpe.—A SERIES OF CHEMICAL PROBLEMS, prepared with Special Reference to Sir H. E. Roscoe's Lessons in Elementary Chemistry, by T. E. THORPE, Ph.D., F.R.S., Professor of Chemistry in the Normal School of Science, South Kensington, adapted for the Preparation of Students for the Government, Science, and Society of Arts Examinations. With a Preface by Sir HENRY E. ROSCOE, F.R.S. New Edition, with Key. 18mo. 2s.

Thorpe and Rücker.—A TREATISE ON CHEMICAL PHYSICS. By T. E. THORPE, Ph.D., F.R.S. Professor of Chemistry in the Normal School of Science, and Professor A. W. RÜCKER. Illustrated. 8vo. [In preparation.]

Wright.—METALS AND THEIR CHIEF INDUSTRIAL APPLICATIONS. By C. ALDER WRIGHT, D.Sc., &c., Lecturer on Chemistry in St. Mary's Hospital Medical School. Extra fcap. 8vo. 3s. 6d.

BIOLOGY.

Allen.—ON THE COLOUR OF FLOWERS, as Illustrated in the British Flora. By GRANT ALLEN. With Illustrations. Crown 8vo. 3s. 6d. (*Nature Series.*)

Balfour.—A TREATISE ON COMPARATIVE EMBRYOLOGY. By F. M. BALFOUR, M.A., F.R.S., Fellow and Lecturer of Trinity College, Cambridge. With Illustrations. Second Edition, reprinted without alteration from the First Edition. In 2 vols. 8vo. Vol. I. 18s. Vol. II. 21s.

Balfour and Ward.—A GENERAL TEXT BOOK OF BOTANY. By ISAAC BAYLEY BALFOUR, F.R.S., Professor of Botany in the University of Oxford, and H. MARSHALL WARD, Fellow of Christ College, Cambridge, and Professor of Botany in the Royal Indian Engineering College, Cooper's Hill. 8vo.
[*In preparation.*]

Bettany.—FIRST LESSONS IN PRACTICAL BOTANY. By G. T. BETTANY, M.A., F.L.S., formerly Lecturer in Botany at Guy's Hospital Medical School. 18mo. 1s.

Bower—Vines.—A COURSE OF PRACTICAL INSTRUCTION IN BOTANY. By F. O. BOWER, M.A., F.L.S., Professor of Botany in the University of Glasgow, and SYDNEY H. VINES, M.A., D.Sc., F.R.S., Fellow and Lecturer, Christ's College, Cambridge. With a Preface by W. T. THISELTON DYER, M.A., C.M.G., F.R.S., F.L.S., Director of the Royal Gardens, Kew.
Part I.—PHANEROGAMÆ — PTERIDOPHYTA. Crown 8vo. 6s.
[*Part II. in preparation.*]

Darwin (Charles).—MEMORIAL NOTICES OF CHARLES DARWIN, F.R.S., &c. By THOMAS HENRY HUXLEY, F.R.S., G. J. ROMANES, F.R.S., ARCHIBALD GEIKIE, F.R.S., and W. T. THISELTON DYER, F.R.S. Reprinted from *Nature*. With a Portrait, engraved by C. H. JEENS. Crown 8vo. 2s. 6d. (*Nature Series.*)

Fearnley.—A MANUAL OF PRACTICAL HISTOLOGY. By Dr. W. FEARNLEY. With Illustrations. Crown 8vo.
[*In the press.*]

Flower and Gadow.—AN INTRODUCTION TO THE OSTEOLOGY OF THE MAMMALIA. By WILLIAM HENRY FLOWER, LL.D., F.R.S., Director of the Natural History Departments of the British Museum, late Hunterian Professor of Comparative Anatomy and Physiology in the Royal College of Surgeons of England. With numerous Illustrations. Third Edition. Revised with the assistance of HANS GADOW, Ph.D., M.A., Lecturer on the Advanced Morphology of Vertebrates and Strickland Curator in the University of Cambridge. Crown 8vo. 10s. 6d.

Foster.—Works by MICHAEL FOSTER, M.D., Sec. R.S., Professor of Physiology in the University of Cambridge.

PRIMER OF PHYSIOLOGY. With numerous Illustrations. New Edition. 18mo. 1s.

A TEXT-BOOK OF PHYSIOLOGY. With Illustrations. Fourth Edition, revised. 8vo. 21s.

Foster and Balfour.—THE ELEMENTS OF EMBRYOLOGY. By MICHAEL FOSTER, M.A., M.D., LL.D., Sec. R.S., Professor of Physiology in the University of Cambridge, Fellow of Trinity College, Cambridge, and the late FRANCIS M. BALFOUR, M.A., LL.D., F.R.S., Fellow of Trinity College, Cambridge, and Professor of Animal Morphology in the University. Second Edition, revised. Edited by ADAM SEDGWICK, M.A., Fellow and Assistant Lecturer of Trinity College, Cambridge, and WALTER HEAPE, Demonstrator in the Morphological Laboratory of the University of Cambridge. With Illustrations. Crown 8vo. 10s. 6d.

Foster and Langley.—A COURSE OF ELEMENTARY PRACTICAL PHYSIOLOGY. By Prof. MICHAEL FOSTER, M.D., Sec. R.S., &c., and J. N. LANGLEY, M.A., F.R.S., Fellow of Trinity College, Cambridge. Fifth Edition. Crown 8vo. 7s. 6d.

Gamgee.—A TEXT-BOOK OF THE PHYSIOLOGICAL CHEMISTRY OF THE ANIMAL BODY. Including an Account of the Chemical Changes occurring in Disease. By A. GAMGEE, M.D., F.R.S., formerly Professor of Physiology in the Victoria University the Owens College, Manchester. 2 Vols. 8vo. With Illustrations. Vol. I. 18s. [Vol. II. in the press.]

Gray.—STRUCTURAL BOTANY, OR ORGANOGRAPHY ON THE BASIS OF MORPHOLOGY. To which are added the principles of Taxonomy and Phytography, and a Glossary of Botanical Terms. By Professor ASA GRAY, LL.D. 8vo. 10s. 6d.

Hooker.—Works by Sir J. D. HOOKER, K.C.S.I., C.B., M.D., F.R.S., D.C.I.
PRIMER OF BOTANY. With numerous Illustrations. New Edition. 18mo. 1s. (*Science Primers.*)

THE STUDENT'S FLORA OF THE BRITISH ISLANDS. Third Edition, revised. Globe 8vo. 10s. 6d.

Howes.—AN ATLAS OF PRACTICAL ELEMENTARY BIOLOGY. By G. B. HOWES, Assistant Professor of Zoology, Normal School of Science and Royal School of Mines. With a Preface by THOMAS HENRY HUXLEY, F.R.S. Royal 4to. 14s.

Huxley.—Works by THOMAS HENRY HUXLEY, F.R.S.
INTRODUCTORY PRIMER OF SCIENCE. 18mo. 1s. (*Science Primers.*)

LESSONS IN ELEMENTARY PHYSIOLOGY. With numerous Illustrations. New Edition Revised. Fcap. 8vo. 4s. 6d.

QUESTIONS ON HUXLEY'S PHYSIOLOGY FOR SCHOOLS. By T. ALCOCK, M.D. New Edition. 18mo. 1s. 6d.

Huxley and Martin.—A COURSE OF PRACTICAL INSTRUCTION IN ELEMENTARY BIOLOGY. By THOMAS HENRY HUXLEY, F.R.S., assisted by H. N. MARTIN, M.B., D.Sc. New Edition, revised. Crown 8vo. 6s.

Kane.—EUROPEAN BUTTERFLIES, A HANDBOOK OF
By W. F. DE VISMES KANE, M.A., M.R.I.A., Member of the
Entomological Society of London, &c. With Copper Plate Illustrations. Crown 8vo. 10s. 6d.

A LIST OF EUROPEAN RHOPALOCERA WITH THEIR
VARIETIES AND PRINCIPAL SYNONYMS. Reprinted
from the *Handbook of European Butterflies*. Crown 8vo. 1s.

Klein.—MICRO-ORGANISMS AND DISEASE. An Intro-
duction into the Study of Specific Micro-Organisms. By E.
KLEIN, M.D., F.R.S., Lecturer on General Anatomy and Physio-
logy in the Medical School of St. Bartholomew's Hospital, London.
With 121 Illustrations. Third Edition, Revised. Crown 8vo. 6s.
THE BACTERIA IN ASIATIC CHOLERA. By the Same.
Crown 8vo. [In preparation.]

Lankester.—Works by Professor E. RAY LANKESTER, F.R.S.
A TEXT BOOK OF ZOOLOGY. 8vo. [In preparation.]
DEGENERATION: A CHAPTER IN DARWINISM. Illus-
trated. Crown 8vo. 2s. 6d. (*Nature Series*.)

Lubbock.—Works by SIR JOHN LUBBOCK, M.P., F.R.S., D.C.L.
THE ORIGIN AND METAMORPHOSES OF INSECTS.
With numerous Illustrations. New Edition. Crown 8vo. 3s. 6d.
(*Nature Series*.)

ON BRITISH WILD FLOWERS CONSIDERED IN RE-
LATION TO INSECTS. With numerous Illustrations. New
Edition. Crown 8vo. 4s. 6d. (*Nature Series*.)

FLOWERS, FRUITS, AND LEAVES. With Illustrations
Crown 8vo. 4s. 6d. (*Nature Series*.)

M'Kendrick.—OUTLINES OF PHYSIOLOGY IN ITS RE-
LATIONS TO MAN. By J. G. M'KENDRICK, M.D., F.R.S.E.
With Illustrations. Crown 8vo. 12s. 6d.

Martin and Moale.—ON THE DISSECTION OF VERTE-
BRATE ANIMALS. By Professor H. N. MARTIN and W. A.
MOALE. Crown 8vo. [In preparation.]

Mivart.—Works by ST. GEORGE MIVART, F.R.S., Lecturer in
Comparative Anatomy at St. Mary's Hospital.

LESSONS IN ELEMENTARY ANATOMY. With upwards of
400 Illustrations. Fcap. 8vo. 6s. 6d.

THE COMMON FROG. With numerous Illustrations. Crown
8vo. 3s. 6d. (*Nature Series*.)

Müller.—THE FERTILISATION OF FLOWERS. By Pro-
fessor HERMANN MÜLLER. Translated and Edited by D'ARCY
W. THOMPSON, B.A., Professor of Biology in University College,
Dundee. With a Preface by CHARLES DARWIN, F.R.S. With
numerous Illustrations. Medium 8vo. 21s.

Oliver.—Works by DANIEL OLIVER, F.R.S., &c., Professor of Botany in University College, London, &c.

FIRST BOOK OF INDIAN BOTANY. With numerous Illustrations. Extra fcap. 8vo. 6s. 6d.

LESSONS IN ELEMENTARY BOTANY. With nearly 200 Illustrations. New Edition. Fcap. 8vo. 4s. 6d.

Parker.—A COURSE OF INSTRUCTION IN ZOOTOMY (VERTEBRATA). By T. JEFFREY PARKER, B.Sc. London, Professor of Biology in the University of Otago, New Zealand. With Illustrations. Crown 8vo. 8s. 6d.

Parker and Bettany.—THE MORPHOLOGY OF THE SKULL. By Professor W. K. PARKER, F.R.S., and G. T. BETTANY. Illustrated. Crown 8vo. 10s. 6d.

Smith (W. G.)—DISEASES OF FIELD AND GARDEN CROPS, CHIEFLY SUCH AS ARE CAUSED BY FUNGI. By WORTHINGTON G. SMITH, F.L.S., M.A.I., Member of the Scientific Committee R.H.S. With 143 New Illustrations drawn and engraved from Nature by the Author. Fcap. 8vo. 4s. 6d.

Wiedersheim (Prof.)—ELEMENTS OF THE COMPARATIVE ANATOMY OF VERTEBRATES. Adapted from the German of ROBERT WIEDERSHEIM, Professor of Anatomy, and Director of the Institute of Human and Comparative Anatomy in the University of Freiburg-in-Baden, by W. NEWTON PARKER, Professor of Biology in the University College of South Wales and Monmouthshire. With Additions by the Author and Translator. With Two Hundred and Seventy Woodcuts. Medium 8vo. 12s. 6d.

MEDICINE.

Brunton.—Works by T. LAUDER BRUNTON, M.D., D.Sc., F.R.C.P., F.R.S., Assistant Physician and Lecturer on Materia Medica at St. Bartholomew's Hospital; Examiner in Materia Medica in the University of London, in the Victoria University, and in the Royal College of Physicians, London; late Examiner in the University of Edinburgh.

A TEXT-BOOK OF PHARMACOLOGY, THERAPEUTICS, AND MATERIA MEDICA. Adapted to the United States Pharmacopœia, by FRANCIS H. WILLIAMS, M.D., Boston, Mass. Third Edition. Adapted to the New British Pharmacopœia, 1885. Medium 8vo. 21s.

TABLES OF MATERIA MEDICA: A Companion to the Materia Medica Museum. With Illustrations. New Edition, Enlarged. 8vo. 10s. 6d.

Hamilton.—A TEXT-BOOK OF PATHOLOGY. By D. J. HAMILTON, Professor of Pathological Anatomy (Sir Erasmus Wilson Chair), University of Aberdeen. 8vo. [*In the press.*]

Klein.—MICRO-ORGANISMS AND DISEASE. An Introduction into the Study of Specific Micro-Organisms. By E. KLEIN, M.D., F.R.S., Lecturer on General Anatomy and Physiology in the Medical School of St. Bartholomew's Hospital, London. With 121 Illustrations. Third Edition, Revised. Crown 8vo 6s.

THE BACTERIA IN ASIATIC CHOLERA. By the Same Author. Crown 8vo. [*In preparation.*]

Ziegler-Macalister.—TEXT-BOOK OF PATHOLOGICAL ANATOMY AND PATHOGENESIS. By Professor ERNST ZIEGLER of Tübingen. Translated and Edited for English Students by DONALD MACALISTER, M.A., M.D., B.Sc., F.R.C.P., Fellow and Medical Lecturer of St. John's College, Cambridge, Physician to Addenbrooke's Hospital, and Teacher of Medicine in the University. With numerous Illustrations. Medium 8vo.

Part I.—GENERAL PATHOLOGICAL ANATOMY. Second Edition. 12s. 6d.

Part II.—SPECIAL PATHOLOGICAL ANATOMY. Sections I.—VIII. Second Edition. 12s. 6d. Sections IX.—XII. 12s. 6d.

ANTHROPOLOGY.

Flower.—FASHION IN DEFORMITY, as Illustrated in the Customs of Barbarous and Civilised Races. By Professor FLOWER, F.R.S., F.R.C.S. With Illustrations. Crown 8vo. 2s. 6d. (*Nature Series.*)

Tylor.—ANTHROPOLOGY. An Introduction to the Study of Man and Civilisation. By E. B. TYLOR, D.C.L., F.R.S. With numerous Illustrations. Crown 8vo. 7s. 6d.

PHYSICAL GEOGRAPHY & GEOLOGY.

Blanford.—THE RUDIMENTS OF PHYSICAL GEOGRAPHY FOR THE USE OF INDIAN SCHOOLS; with a Glossary of Technical Terms employed. By H. F. BLANFORD, F.R.S. New Edition, with Illustrations. Globe 8vo. 2s. 6d.

Geikie.—Works by ARCHIBALD GEIKIE, LL.D., F.R.S., Director General of the Geological Survey of Great Britain and Ireland, and Director of the Museum of Practical Geology, London, formerly Murchison Professor of Geology and Mineralogy in the University of Edinburgh, &c.

PRIMER OF PHYSICAL GEOGRAPHY. With numerous Illustrations. New Edition. With Questions. 18mo. 1s. (*Science Primers.*)

Geikie.—Works by ARCHIBALD GEIKIE, LL.D., F.R.S., &c.
(continued)—

ELEMENTARY LESSONS IN PHYSICAL GEOGRAPHY.

With numerous Illustrations. New Edition. Fcap. 8vo. 4s. 6d.

QUESTIONS ON THE SAME. 1s. 6d.

PRIMER OF GEOLOGY. With numerous Illustrations. New Edition. 18mo. 1s. (*Science Primers.*)

CLASS BOOK OF GEOLOGY. With upwards of 200 New Illustrations. Crown 8vo. 10s. 6d.

TEXT-BOOK OF GEOLOGY. With numerous Illustrations. Second Edition, Fifth Thousand, Revised and Enlarged. 8vo. 28s.

OUTLINES OF FIELD GEOLOGY. With Illustrations. New Edition. Extra fcap. 8vo. 3s. 6d.

(See also under *History and Geography.*)

Huxley.—PHYSIOGRAPHY. An Introduction to the Study of Nature. By THOMAS HENRY HUXLEY, F.R.S. With numerous Illustrations, and Coloured Plates. New and Cheaper Edition. Crown 8vo. 6s.

Phillips.—A TREATISE ON ORE DEPOSITS. By J. ARTHUR PHILLIPS, F.R.S., V.P.G.S., F.C.S., M.Inst.C.E., Ancien élève de l'École des Mines, Paris; Author of "A Manual of Metallurgy," "The Mining and Metallurgy of Gold and Silver," &c. With numerous Illustrations. 8vo. 25s.

AGRICULTURE.

Frankland.—AGRICULTURAL CHEMICAL ANALYSIS, A Handbook of. By PERCY FARADAY FRANKLAND, Ph.D., B.Sc., F.C.S., Associate of the Royal School of Mines, and Demonstrator of Practical and Agricultural Chemistry in the Normal School of Science and Royal School of Mines, South Kensington Museum. Founded upon *Leitfaden für die Agriculture Chemische Analyse*, von Dr. F. KROCKER. Crown 8vo. 7s. 6d.

Smith (Worthington G.).—DISEASES OF FIELD AND GARDEN CROPS, CHIEFLY SUCH AS ARE CAUSED BY FUNGI. By WORTHINGTON G. SMITH, F.L.S., M.A.I., Member of the Scientific Committee of the R.H.S. With 143 Illustrations, drawn and engraved from Nature by the Author. Fcap. 8vo. 4s. 6d.

Tanner.—Works by HENRY TANNER, F.C.S., M.R.A.C., Examiner in the Principles of Agriculture under the Government Department of Science; Director of Education in the Institute of Agriculture, South Kensington, London; sometime Professor of Agricultural Science, University College, Aberystwith.

ELEMENTARY LESSONS IN THE SCIENCE OF AGRICULTURAL PRACTICE. Fcap. 8vo. 3s. 6d.

Tanner.—Works by HENRY TANNER, F.C.S., M.R.A.C., &c.
(continued)—

FIRST PRINCIPLES OF AGRICULTURE. 18mo. 1s.

THE PRINCIPLES OF AGRICULTURE. A Series of Reading Books for use in Elementary Schools. Prepared by HENRY TANNER, F.C.S., M.R.A.C. Extra fcap. 8vo.

I. The Alphabet of the Principles of Agriculture. 6d.

II. Further Steps in the Principles of Agriculture. 1s.

III. Elementary School Readings on the Principles of Agriculture for the third stage. 1s.

POLITICAL ECONOMY.

Cossa.—GUIDE TO THE STUDY OF POLITICAL ECONOMY. By Dr. LUIGI COSSA, Professor in the University of Pavia. Translated from the Second Italian Edition. With a Preface by W. STANLEY JEVONS, F.R.S. Crown 8vo. 4s. 6d.

Fawcett (Mrs.).—Works by MILLICENT GARRETT FAWCETT:—POLITICAL ECONOMY FOR BEGINNERS, WITH QUESTIONS. Fourth Edition. 18mo. 2s. 6d.

TALES IN POLITICAL ECONOMY. Crown 8vo. 3s.

Fawcett.—A MANUAL OF POLITICAL ECONOMY. By Right Hon. HENRY FAWCETT, F.R.S. Sixth Edition, revised, with a chapter on "State Socialism and the Nationalisation of the Land," and an Index. Crown 8vo. 12s.

Jevons.—PRIMER OF POLITICAL ECONOMY. By W. STANLEY JEVONS, LL.D., M.A., F.R.S. New Edition. 18mo. 1s. (*Science Primers.*)

Marshall.—THE ECONOMICS OF INDUSTRY. By A. MARSHALL, M.A., Professor of Political Economy in the University of Cambridge, and MARY P. MARSHALL, late Lecturer at Newnham Hall, Cambridge. Extra fcap. 8vo. 2s. 6d.

Sidgwick.—THE PRINCIPLES OF POLITICAL ECONOMY. By Professor HENRY SIDGWICK, M.A., LL.D., Knightbridge Professor of Moral Philosophy in the University of Cambridge, &c., Author of "The Methods of Ethics." 8vo. 16s.

Walker.—Works by FRANCIS A. WALKER, M.A., Ph.D., Author of "Money," "Money in its Relation to Trade," &c.

POLITICAL ECONOMY. 8vo. 10s. 6d.

A BRIEF TEXT-BOOK OF POLITICAL ECONOMY. Crown 8vo. 6s. 6d.

THE WAGES QUESTION. 8vo. 14s.

MENTAL & MORAL PHILOSOPHY.

Calderwood.—HANDBOOK OF MORAL PHILOSOPHY. By the Rev. HENRY CALDERWOOD, LL.D., Professor of Moral Philosophy, University of Edinburgh. New Edition. Crown 8vo. 6s.

Clifford.—SEEING AND THINKING. By the late Professor W. K. CLIFFORD, F.R.S. With Diagrams. Crown 8vo. 3s. 6d. (*Nature Series.*)

Jardine.—THE ELEMENTS OF THE PSYCHOLOGY OF COGNITION. By the Rev. ROBERT JARDINE, B.D., D.Sc. (Edin.), Ex-Principal of the General Assembly's College, Calcutta. Third Edition, revised and improved. Crown 8vo. 6s. 6d.

Jevons.—Works by the late W. STANLEY JEVONS, LL.D., M.A., F.R.S.

PRIMER OF LOGIC. New Edition. 18mo. 1s. (*Science Primers.*)

ELEMENTARY LESSONS IN LOGIC; Deductive and Inductive, with copious Questions and Examples, and a Vocabulary of Logical Terms. New Edition. Fcap. 8vo. 3s. 6d.

THE PRINCIPLES OF SCIENCE. A Treatise on Logic and Scientific Method. New and Revised Edition. Crown 8vo. 12s. 6d.

STUDIES IN DEDUCTIVE LOGIC. Second Edition. Cr. 8vo. 6s.

Keynes.—FORMAL LOGIC, Studies and Exercises in. Including a Generalisation of Logical Processes in their application to Complex Inferences. By JOHN NEVILLE KEYNES, M.A., late Fellow of Pembroke College, Cambridge. Crown 8vo. 10s. 6d.

Kant—Max Müller.—CRITIQUE OF PURE REASON. By IMMANUEL KANT. In commemoration of the Centenary of its first Publication. Translated into English by F. MAX MÜLLER. With an Historical Introduction by LUDWIG NOIRÉ. 2 vols. Demy 8vo. 16s. each.

Volume I. HISTORICAL INTRODUCTION, by LUDWIG NOIRÉ; &c., &c.

Volume II. CRITIQUE OF PURE REASON, translated by F. MAX MÜLLER.

For the convenience of students these volumes are now sold separately.

McCosh.—PSYCHOLOGY.—THE COGNITIVE POWERS. By JAMES MCCOSH, D.D., LL.D., Litt.D., President of Princeton College, Author of "Intuitions of the Mind," "Laws of Discursive Thought," &c. Crown 8vo. 6s. 6d.

Ray.—A TEXT-BOOK OF DEDUCTIVE LOGIC FOR THE USE OF STUDENTS. By P. K. RAY, D.Sc. (Lon. and Edin.), Professor of Logic and Philosophy, Presidency College, Calcutta. Second Edition. Globe 8vo. 4s. 6d.

Sidgwick.—Works by HENRY SIDGWICK, M.A., LL.D., Knight-bridge Professor of Moral Philosophy in the University of Cambridge.

THE METHODS OF ETHICS. Third Edition. 8vo. 14s. A Supplement to the Second Edition, containing all the important Additions and Alterations in the Third Edition. Demy 8vo. 6s.

OUTLINES OF THE HISTORY OF ETHICS, for English Readers. Crown 8vo. 3s. 6d.

HISTORY AND GEOGRAPHY.

- Arnold (T.).**—THE SECOND PUNIC WAR. Being Chapters from THE HISTORY OF ROME. By THOMAS ARNOLD, D.D. Edited, with Notes, by W. T. ARNOLD, M.A. With 8 Maps. Crown 8vo. 8s. 6d.
- Arnold (W. T.).**—THE ROMAN SYSTEM OF PROVINCIAL ADMINISTRATION TO THE ACCESSION OF CONSTANTINE THE GREAT. By W. T. ARNOLD, M.A. Crown 8vo. 6s.
 "Ought to prove a valuable handbook to the student of Roman history."—*GUARDIAN*.
- Beesly.**—STORIES FROM THE HISTORY OF ROME. By Mrs. BEESLY. Fcap. 8vo. 2s. 6d.
- Bryce.**—THE HOLY ROMAN EMPIRE. By JAMES BRYCE, D.C.L., Fellow of Oriel College, and Regius Professor of Civil Law in the University of Oxford. Eighth Edition. Crown 8vo. 7s. 6d.
- Buckland.**—OUR NATIONAL INSTITUTIONS. A Short Sketch for Schools. By ANNA BUCKLAND. 18mo. 1s.
- Buckley.**—A HISTORY OF ENGLAND FOR BEGINNERS. By ARABELLA BUCKLEY. Author of "A Short History of Natural Science," &c. With Maps. Globe 8vo. [*Nearly ready.*]
- Clarke.**—CLASS-BOOK OF GEOGRAPHY. By C. B. CLARKE, M.A., F.L.S., F.G.S., F.R.S. New Edition, with Eighteen Coloured Maps. Fcap. 8vo. 3s.
- Dicey.**—LECTURES INTRODUCTORY TO THE STUDY OF THE LAW OF THE CONSTITUTION. By A. V. DICEY, B.C.L., of the Inner Temple, Barrister-at-Law; Vinerian Professor of English Law; Fellow of All Souls College, Oxford; Hon. LL.D. Glasgow. Second Edition. Demy 8vo. 12s. 6d.
- Dickens's** DICTIONARY OF THE UNIVERSITY OF OXFORD, 1886-7. 18mo, sewed. 1s.
- Dickens's** DICTIONARY OF THE UNIVERSITY OF CAMBRIDGE, 1886-7. 18mo, sewed. 1s.
 Both books (Oxford and Cambridge) bound together in one volume. Cloth. 2s. 6d.
- Freeman.**—Works by EDWARD A. FREEMAN, D.C.L., LL.D., Regius Professor of Modern History in the University of Oxford, &c.
 OLD ENGLISH HISTORY. With Five Coloured Maps. New Edition. Extra fcap. 8vo. 6s.
 A SCHOOL HISTORY OF ROME. Crown 8vo. [*In preparation.*]
 METHODS OF HISTORICAL STUDY. A Course of Lectures. 8vo. 10s. 6d.
 THE CHIEF PERIODS OF EUROPEAN HISTORY. Six Lectures read in the University of Oxford in Trinity Term, 1885. With an Essay on Greek Cities under Roman Rule. 8vo. 10s. 6d.

Freeman.—Works by EDWARD A FREEMAN, D.C.L., LL.D., &c.
(continued)—

HISTORICAL ESSAYS. First Series. Fourth Edition. 8vo.
10s. 6d.

Contents:—The Mythical and Romantic Elements in Early English History—The Continuity of English History—The Relations between the Crown of England and Scotland—St. Thomas of Canterbury and his Biographers, &c.

HISTORICAL ESSAYS. Second Series. Second Edition, with additional Essays. 8vo. 10s. 6d.

Contents:—Ancient Greece and Mediæval Italy—Mr. Gadstone's Homer and the Homeric Ages—The Historians of Athens—The Athenian Democracy—Alexander the Great—Greece during the Macedonian Period—Mommson's History of Rome—Lucius Cornelius Sulla—The Flavian Cæsars, &c., &c.

HISTORICAL ESSAYS. Third Series. 8vo. 12s.

Contents:—First Impressions of Rome—The Illyrian Emperors and their Land—Augusta Treverorum—The Goths at Ravenna—Race and Language—The Byzantine Empire—First Impressions of Athens—Mediæval and Modern Greece—The Southern Slaves—Sicilian Cycles—The Normans at Palermo.

THE GROWTH OF THE ENGLISH CONSTITUTION FROM THE EARLIEST TIMES. Fourth Edition. Crown 8vo. 5s.

GENERAL SKETCH OF EUROPEAN HISTORY. New Edition. Enlarged, with Maps, &c. 18mo. 3s. 6d. (Vol. I. of Historical Course for Schools.)

EUROPE. 18mo. 1s. (*History Primers.*)

Fyffe.—A SCHOOL HISTORY OF GREECE. By C. A. FYFFE, M.A. Crown 8vo. [*In preparation.*]

Geikie.—THE TEACHING OF GEOGRAPHY. A Practical Handbook for the use of Teachers. By ARCHIBALD GEIKIE, F.R.S., Director-General of the Geological Survey of the United Kingdom, and Director of the Museum of Practical Geology, Jermyn Street, London; formerly Murchison Professor of Geology and Mineralogy in the University of Edinburgh. Crown 8vo. Being Volume I. of a New Geographical Series Edited by ARCHIBALD GEIKIE, F.R.S. [*In the press.*]

* * The aim of this volume is to advocate the claims of geography as an educational discipline of a high order, and to show how these claims may be practically recognised by teachers. This introductory volume is intended to be followed by a short Geography of the British Islands, and then by other volumes as announced on pp. 48, 49.

Green.—Works by JOHN RICHARD GREEN, M.A., LL.D., late Honorary Fellow of Jesus College, Oxford.

SHORT HISTORY OF THE ENGLISH PEOPLE. With Coloured Maps, Genealogical Tables, and Chronological Annals. Crown 8vo. 8s. 6d. 122nd Thousand.

"Stands alone as the one general history of the country, for the sake of which all others, if young and old are wise, will be speedily and surely set aside."—ACADEMY.

ANALYSIS OF ENGLISH HISTORY, based on Green's "Short History of the English People." By C. W. A. TAIT, M.A., Assistant-Master, Clifton College. Crown 8vo. 3s. 6d.

Green.—Works by JOHN RICHARD GREEN, M.A., LL.D., &c.
(*continued*)—

READINGS FROM ENGLISH HISTORY. Selected and Edited by JOHN RICHARD GREEN. Three Parts. Globe 8vo. 1s. 6d. each. I. Hengist to Cressy. II. Cressy to Cromwell. III. Cromwell to Balaklava.

Green.—A SHORT GEOGRAPHY OF THE BRITISH ISLANDS. By JOHN RICHARD GREEN and ALICE STOPFORD GREEN. With Maps. Fcap. 8vo. 3s. 6d.

Grove.—A PRIMER OF GEOGRAPHY. By Sir GEORGE GROVE, D.C.L. With Illustrations. 18mo. 1s. (*Science Primers.*)

Guest.—LECTURES ON THE HISTORY OF ENGLAND. By M. J. GUEST. With Maps. Crown 8vo. 6s.

Historical Course for Schools—Edited by EDWARD A. FREEMAN, D.C.L., LL.D., late Fellow of Trinity College, Oxford, Regius Professor of Modern History in the University of Oxford.

I.—GENERAL SKETCH OF EUROPEAN HISTORY. By EDWARD A. FREEMAN, D.C.L. New Edition, revised and enlarged, with Chronological Table, Maps, and Index. 18mo. 3s. 6d.

II.—HISTORY OF ENGLAND. By EDITH THOMPSON. New Ed., revised and enlarged, with Coloured Maps. 18mo. 2s. 6d.

III.—HISTORY OF SCOTLAND. By MARGARET MACARTHUR. New Edition. 18mo. 2s.

IV.—HISTORY OF ITALY. By the Rev. W. HUNT, M.A. New Edition, with Coloured Maps. 18mo. 3s. 6d.

V.—HISTORY OF GERMANY. By J. SIME, M.A. New Edition Revised. 18mo. 3s.

VI.—HISTORY OF AMERICA. By JOHN A. DOYLE. With Maps. 18mo. 4s. 6d.

VII.—EUROPEAN COLONIES. By E. J. PAYNE, M.A. With Maps. 18mo. 4s. 6d.

VIII.—FRANCE. By CHARLOTTE M. YONGE. With Maps. 18mo. 3s. 6d.

GREECE. By EDWARD A. FREEMAN, D.C.L. [*In preparation.*]

ROME. By EDWARD A. FREEMAN, D.C.L. [*In preparation.*]

History Primers—Edited by JOHN RICHARD GREEN, M.A., LL.D., Author of "A Short History of the English People."

ROME. By the Rev. M. CREIGHTON, M.A., Dixie Professor of Ecclesiastical History in the University of Cambridge. With Eleven Maps. 18mo. 1s.

GREECE. By C. A. FYFFE, M.A., Fellow and late Tutor of University College, Oxford. With Five Maps. 18mo. 1s.

EUROPEAN HISTORY. By E. A. FREEMAN, D.C.L., LL.D. With Maps. 18mo. 1s.

History Primers.—Edited by JOHN RICHARD GREEN, M.A., LL.D., &c. (*continued*)—

GREEK ANTIQUITIES. By the Rev. J. P. MAHAFFY, M.A. Illustrated. 18mo. 1s.

CLASSICAL GEOGRAPHY. By H. F. TOZER, M.A. 18mo. 1s.

GEOGRAPHY. By Sir G. GROVE, D.C.L. Maps. 18mo. 1s.

ROMAN ANTIQUITIES. By Professor WILKINS. Illustrated. 18mo. 1s.

FRANCE. By CHARLOTTE M. YONGE. 18mo. 1s.

Hole.—A GENEALOGICAL STEMMA OF THE KINGS OF ENGLAND AND FRANCE. By the Rev. C. HOLE. On Sheet. 1s.

Jennings—CHRONOLOGICAL TABLES. Compiled by Rev. A. C. JENNINGS. [*In the press.*]

Kiepert.—A MANUAL OF ANCIENT GEOGRAPHY. From the German of Dr. H. KIEPERT. Crown 8vo. 5s.

Labberton.—AN HISTORICAL ATLAS. Comprising 141 Maps, to which is added, besides an Explanatory Text on the period delineated in each Map, a carefully selected Bibliography of the English Books and Magazine Articles bearing on that Period. By R. H. LABBERTON, Litt.Hum.D. 4to. 12s. 6d.

Lethbridge.—A SHORT MANUAL OF THE HISTORY OF INDIA. With an Account of INDIA AS IT IS. The Soil, Climate, and Productions; the People, their Races, Religions, Public Works, and Industries; the Civil Services, and System of Administration. By Sir ROPER LETHBRIDGE, M.A., C.I.E., late Scholar of Exeter College, Oxford, formerly Principal of Kishinagar College, Bengal, Fellow and sometime Examiner of the Calcutta University. With Maps. Crown 8vo. 5s.

Michelet.—A SUMMARY OF MODERN HISTORY. Translated from the French of M. MICHELET, and continued to the Present Time, by M. C. M. SIMPSON. Globe 8vo. 4s. 6d.

Otté.—SCANDINAVIAN HISTORY. By E. C. OTTÉ. With Maps. Globe 8vo. 6s.

Ramsay.—A SCHOOL HISTORY OF ROME. By G. G. RAMSAY, M.A., Professor of Humanity in the University of Glasgow. With Maps. Crown 8vo. [*In preparation.*]

Tait.—ANALYSIS OF ENGLISH HISTORY, based on Green's "Short History of the English People." By C. W. A. TAIT, M.A., Assistant-Master, Clifton College. Crown 8vo. 3s. 6d.

Wheeler.—A SHORT HISTORY OF INDIA AND OF THE FRONTIER STATES OF AFGHANISTAN, NEPAUL, AND BURMA. By J. TALBOYS WHEELER. With Maps. Crown 8vo. 12s.

Yonge (Charlotte M.). — CAMEOS FROM ENGLISH HISTORY. By CHARLOTTE M. YONGE, Author of "The Heir of Redclyffe," Extra fcap. 8vo. New Edition. 5s. each. (1) FROM ROLLO TO EDWARD II. (2) THE WARS IN FRANCE. (3) THE WARS OF THE ROSES. (4) REFORMATION TIMES. (5) ENGLAND AND SPAIN. (6) FORTY YEARS OF STUART RULE.

EUROPEAN HISTORY. Narrated in a Series of Historical Selections from the Best Authorities. Edited and arranged by E. M. SEWELL and C. M. YONGE. First Series, 1003—1154. New Edition. Crown 8vo. 6s. Second Series, 1088—1228. New Edition. Crown 8vo. 6s.

THE VICTORIAN HALF CENTURY—A JUBILEE BOOK. With a New Portrait of the Queen. Crown 8vo. paper covers, 1s. Cloth, 1s. 6d.

MODERN LANGUAGES AND LITERATURE.

(1) English, (2) French, (3) German, (4) Modern Greek, (5) Italian.

ENGLISH.

Abbott.—A SHAKESPEARIAN GRAMMAR. An attempt to illustrate some of the Differences between Elizabethan and Modern English. By the Rev. E. A. ABBOTT, D.D., Head Master of the City of London School. New Edition. Extra fcap. 8vo. 6s.

Brooke.—PRIMER OF ENGLISH LITERATURE. By the Rev. STOPFORD A. BROOKE, M.A. 18mo. 1s. (*Literature Primers.*)

Butler.—HUDIBRAS. Edited, with Introduction and Notes, by ALFRED MILNES, M.A. Lon., late Student of Lincoln College, Oxford. Extra fcap 8vo. Part I. 3s. 6d. Parts II. and III. 4s. 6d.

Cowper's TASK: AN EPISTLE TO JOSEPH HILL, ESQ.; TIROCINIUM, or a Review of the Schools; and THE HISTORY OF JOHN GILPIN. Edited, with Notes, by WILLIAM BENHAM, B.D. Globe 8vo. 1s. (*Globe Readings from Standard Authors.*)

Dowden.—SHAKESPEARE. By Professor DOWDEN. 18mo. 1s. (*Literature Primers.*)

Dryden.—SELECT PROSE WORKS. Edited, with Introduction and Notes, by Professor C. D. YONGE. Fcap. 8vo. 2s. 6d.

Gladstone.—SPELLING REFORM FROM AN EDUCATIONAL POINT OF VIEW. By J. H. GLADSTONE, Ph.D., F.R.S., Member of the School Board for London. New Edition. Crown 8vo. 1s. 6d.

Globe Readers. For Standards I.—VI. Edited by A. F. MURISON. Sometime English Master at the Aberdeen Grammar School. With Illustrations. Globe 8vo.

Primer I. (48 pp.) 3*d*.

Primer II. (48 pp.) 3*d*.

Book I. (96 pp.) 6*d*.

Book II. (136 pp.) 9*d*.

Book III. (232 pp.) 1*s*. 3*d*.

Book IV. (328 pp.) 1*s*. 9*d*.

Book V. (416 pp.) 2*s*.

Book VI. (448 pp.) 2*s*. 6*d*.

"Among the numerous sets of readers before the public the present series is honourably distinguished by the marked superiority of its materials and the careful ability with which they have been adapted to the growing capacity of the pupils. The plan of the two primers is excellent for facilitating the child's first attempts to read. In the first three following books there is abundance of entertaining reading. . . . Better food for young minds could hardly be found."—*THE ATHENÆUM*.

***The Shorter Globe Readers.**—With Illustrations. Globe 8vo.

Primer I. (48 pp.) 3*d*.

Primer II. (48 pp.) 3*d*.

Standard I. (92 pp.) 6*d*.

Standard II. (124 pp.) 9*d*.

Standard III. (178 pp.) 1*s*.

Standard IV. (182 pp.) 1*s*.

Standard V. (216 pp.) 1*s*. 3*d*.

Standard VI. (228 pp.) 1*s*. 6*d*.

* This Series has been abridged from "The Globe Readers" to meet the demand for smaller reading books.

GLOBE READINGS FROM STANDARD AUTHORS.

Cowper's TASK: AN EPISTLE TO JOSEPH HILL, ESQ.; TIROCINIUM, or a Review of the Schools; and THE HISTORY OF JOHN GILPIN. Edited, with Notes, by WILLIAM BENHAM, B.D. Globe 8vo. 1*s*.

Goldsmith's VICAR OF WAKEFIELD. With a Memoir of Goldsmith by Professor MASSON. Globe 8vo. 1*s*.

Lamb's (Charles) TALES FROM SHAKESPEARE. Edited, with Preface, by ALFRED AINGER, M.A. Globe 8vo. 2*s*.

Scott's (Sir Walter) LAY OF THE LAST MINSTREL; and THE LADY OF THE LAKE. Edited, with Introductions and Notes, by FRANCIS TURNER PALGRAVE. Globe 8vo. 1*s*.
MARMION; and the LORD OF THE ISLES. By the same Editor. Globe 8vo. 1*s*.

The Children's Garland from the Best Poets.—Selected and arranged by COVENTRY PATMORE. Globe 8vo. 2*s*.

Yonge (Charlotte M.).—A BOOK OF GOLDEN DEEDS OF ALL TIMES AND ALL COUNTRIES. Gathered and narrated anew by CHARLOTTE M. YONGE, the Author of "The Heir of Redclyffe." Globe 8vo. 2*s*.

Goldsmith.—THE TRAVELLER, or a Prospect of Society; and THE DESERTED VILLAGE. By OLIVER GOLDSMITH. With Notes, Philological and Explanatory, by J. W. HALES, M.A. Crown 8vo. 6d.

THE VICAR OF WAKEFIELD. With a Memoir of Goldsmith by Professor MASSON. Globe 8vo. 1s. (*Globe Readings from Standard Authors.*)

SELECT ESSAYS. Edited, with Introduction and Notes, by Professor C. D. YONGE. Fcap. 8vo. 2s. 6d.

Hales.—LONGER ENGLISH POEMS, with Notes, Philological and Explanatory, and an Introduction on the Teaching of English, Chiefly for Use in Schools. Edited by J. W. HALES, M.A., Professor of English Literature at King's College, London. New Edition. Extra fcap. 8vo. 4s. 6d.

Johnson's LIVES OF THE POETS. The Six Chief Lives (Milton, Dryden, Swift, Addison, Pope, Gray), with Macaulay's "Life of Johnson." Edited with Preface and Notes by MATTHEW ARNOLD. New and cheaper edition. Crown 8vo. 4s. 6d.

Lamb (Charles).—TALES FROM SHAKESPEARE. Edited, with Preface, by ALFRED AINGER, M.A. Globe 8vo. 2s. (*Globe Readings from Standard Authors.*)

Literature Primers—Edited by JOHN RICHARD GREEN, M.A., LL.D., Author of "A Short History of the English People."

ENGLISH COMPOSITION. By Professor NICHOL. 18mo. 1s.

ENGLISH GRAMMAR. By the Rev. R. MORRIS, LL.D., sometime President of the Philological Society. 18mo. 1s.

ENGLISH GRAMMAR EXERCISES. By R. MORRIS, LL.D., and H. C. BOWEN, M.A. 18mo. 1s.

EXERCISES ON MORRIS'S PRIMER OF ENGLISH GRAMMAR. By JOHN WETHERELL, of the Middle School, Liverpool College. 18mo. 1s.

ENGLISH LITERATURE. By STOPFORD BROOKE, M.A. New Edition. 18mo. 1s.

SHAKSPERE. By Professor DOWDEN. 18mo. 1s.

THE CHILDREN'S TREASURY OF LYRICAL POETRY. Selected and arranged with Notes by FRANCIS TURNER PALGRAVE. In Two Parts. 18mo. 1s. each.

PHILOLOGY. By J. PEILE, M.A. 18mo. 1s.

A History of English Literature in Four Volumes.
Crown 8vo.

EARLY ENGLISH LITERATURE. By STOPFORD BROOKE, M.A. [*In preparation.*]

ELIZABETHIAN LITERATURE. By GEORGE SAINTSBURY. [*In the press.*]

THE AGE OF QUEEN ANNE. By EDMUND GOSSE. [*In prep.*]

THE MODERN PERIOD. By PROFESSOR E. DOWDEN. [*In prep.*]

Macmillan's Reading Books.—Adapted to the English and Scotch Codes. Bound in Cloth.

PRIMER. 18mo. (48 pp.) 2d.	BOOK III. for Standard III. 18mo. (160 pp.) 6d.
BOOK I. for Standard I. 18mo. (96 pp.) 4d.	
BOOK II. for Standard II. 18mo. (144 pp.) 5d.	BOOK IV. for Standard IV. 18mo. (176 pp.) 8d.
BOOK V. for Standard V. 18mo. (380 pp.) 1s.	BOOK VI. for Standard VI. Cr. 8vo. (430 pp.) 2s.

Book VI. is fitted for higher Classes, and as an Introduction to English Literature.

Macmillan's Copy-Books—

Published in two sizes, viz. :—

1. Large Post 4to. Price 4d. each.
2. Post Oblong. Price 2d. each.

1. INITIATORY EXERCISES AND SHORT LETTERS.
2. WORDS CONSISTING OF SHORT LETTERS.
- *3. LONG LETTERS. With Words containing Long Letters—Figures.
- *4. WORDS CONTAINING LONG LETTERS.
- 4*u*. PRACTISING AND REVISING COPY-BOOK. For Nos. 1 to 4.
- *5. CAPITALS AND SHORT HALF-TEXT. Words beginning with a Capital.
- *6. HALF-TEXT WORDS beginning with Capitals—Figures.
- *7. SMALL-HAND AND HALF-TEXT. With Capitals and Figures.
- *8. SMALL-HAND AND HALF-TEXT. With Capitals and Figures.
- 8*a*. PRACTISING AND REVISING COPY-BOOK. For Nos. 5 to 8.
- *9. SMALL-HAND SINGLE HEADLINES—Figures.
10. SMALL-HAND SINGLE HEADLINES—Figures.
11. SMALL-HAND DOUBLE HEADLINES—Figures.
12. COMMERCIAL AND ARITHMETICAL EXAMPLES, &c.
- 12*a*. PRACTISING AND REVISING COPY-BOOK. For Nos. 8 to 12.

* *These numbers may be had with Goodman's Patent Sliding Copies. Large Post 4to. Price 6d. each.*

Martin.—THE POET'S HOUR: Poetry selected and arranged for Children. By FRANCES MARTIN. New Edition. 18mo. 2s. 6d.

SPRING-TIME WITH THE POETS: Poetry selected by FRANCES MARTIN. New Edition. 18mo. 3s 6d.

Milton.—By STOPFORD BROOKE, M.A. Fcap. 8vo. 1s. 6d. (*Classical Writers Series.*)

Morris.—Works by the Rev. R. MORRIS, LL.D.

HISTORICAL OUTLINES OF ENGLISH ACCIDENCE, comprising Chapters on the History and Development of the Language, and on Word-formation. New Edition. Extra fcap. 8vo. 6s.

ELEMENTARY LESSONS IN HISTORICAL ENGLISH GRAMMAR, containing Accidence and Word-formation. New Edition. 18mo. 2s. 6d.

PRIMER OF ENGLISH GRAMMAR. 18mo. 1s. (See also *Literature Primers.*)

Oliphant.—THE OLD AND MIDDLE ENGLISH. A New Edition of "THE SOURCES OF STANDARD ENGLISH," revised and greatly enlarged. By T. L. KINGTON OLIPHANT. Extra fcap. 8vo. 9s.

THE NEW ENGLISH. By the same Author. 2 vols. Cr. 8vo. 21s.

Palgrave.—THE CHILDREN'S TREASURY OF LYRICAL POETRY. Selected and arranged, with Notes, by FRANCIS TURNER PALGRAVE. 18mo. 2s. 6d. Also in Two Parts. 18mo. 1s. each.

Patmore.—THE CHILDREN'S GARLAND FROM THE BEST POETS. Selected and arranged by COVENTRY PATMORE. Globe 8vo. 2s. (*Globe Readings from Standard Authors.*)

Plutarch.—Being a Selection from the Lives which Illustrate Shakespeare. North's Translation. Edited, with Introductions, Notes, Index of Names, and Glossarial Index, by the Rev. W. W. SKEAT, M.A. Crown 8vo. 6s.

Scott's (Sir Walter) LAY OF THE LAST MINSTREL, and THE LADY OF THE LAKE. Edited, with Introduction and Notes, by FRANCIS TURNER PALGRAVE. Globe 8vo. 1s. (*Globe Readings from Standard Authors.*)

MARMION; and THE LORD OF THE ISLES. By the same Editor. Globe 8vo. 1s. (*Globe Readings from Standard Authors.*)

Shakespeare.—A SHAKESPERIAN GRAMMAR. By Rev. E. A. ABBOTT, D.D., Head Master of the City of London School. Globe 8vo. 6s.

A SHAKESPEARE MANUAL. By F. G. FLEAY, M.A., late Head Master of Skipton Grammar School. Second Edition. Extra fcap. 8vo. 4s. 6d.

PRIMER OF SHAKESPEARE. By Professor DOWDEN. 18mo. 1s. (*Literature Primers.*)

Sonnenschein and Meiklejohn.—THE ENGLISH METHOD OF TEACHING TO READ. By A. SONNENSCHIEIN and J. M. D. MEIKLEJOHN, M.A. Fcap. 8vo.

COMPRISING :

THE NURSERY BOOK, containing all the Two-Letter Words in the Language. 1d. (Also in Large Type on Sheets for School Walls. 5s.)

THE FIRST COURSE, consisting of Short Vowels with Single Consonants. 6d.

THE SECOND COURSE, with Combinations and Bridges, consisting of Short Vowels with Double Consonants. 6d.

THE THIRD AND FOURTH COURSES, consisting of Long Vowels, and all the Double Vowels in the Language. 6d.

"These are admirable books, because they are constructed on a principle, and that the simplest principle on which it is possible to learn to read English."—SPECTATOR.

Taylor.—WORDS AND PLACES; or, Etymological Illustrations of History, Ethnology, and Geography. By the Rev. ISAAC TAYLOR, M.A., Litt. D., Hon. LL.D., Canon of York. Third and Cheaper Edition, revised and compressed. With Maps. Globe 8vo. 6s.

Tennyson.—THE COLLECTED WORKS of LORD TENNYSON, Poet Laureate. An Edition for Schools. In Four Parts. Crown 8vo. 2s. 6d. each.

SELECTIONS FROM LORD TENNYSON'S POEMS. Edited with Notes for the Use of Schools. By the Rev. ALFRED AINGER, M.A., LL.D. [*In preparation.*]

Thring.—THE ELEMENTS OF GRAMMAR TAUGHT IN ENGLISH. By EDWARD THRING, M.A., Head Master of Uppingham. With Questions. Fourth Edition. 18mo. 2s.

Vaughan (C.M.).—WORDS FROM THE POETS. By C. M. VAUGHAN. New Edition. 18mo, cloth. 1s.

Ward.—THE ENGLISH POETS. Selections, with Critical Introductions by various Writers and a General Introduction by MATTHEW ARNOLD. Edited by T. H. WARD, M.A. 4 Vols. Vol. I. CHAUCER TO DONNE.—Vol. II. BEN JONSON TO DRYDEN.—Vol. III. ADDISON TO BLAKE.—Vol. IV. WORDSWORTH TO ROSSETTI. Crown 8vo. Each 7s. 6d.

Wetherell.—EXERCISES ON MORRIS'S PRIMER OF ENGLISH GRAMMAR. By JOHN WETHERELL, M.A. 18mo. 1s. (*Literature Primers.*)

Woods.—A FIRST SCHOOL POETRY BOOK. Compiled by M. A. WOODS, Head Mistress of the Clifton High School for Girls. Fcap. 8vo. 2s. 6d.

A SECOND SCHOOL POETRY BOOK. By the same Author. Fcap. 8vo. [*In preparation.*]

Yonge (Charlotte M.).—THE ABRIDGED BOOK OF GOLDEN DEEDS. A Reading Book for Schools and general readers. By the Author of "The Heir of Redclyffe." 18mo, cloth. 1s. GLOBE READINGS EDITION. Globe 8vo. 2s. (See p. 56.)

FRENCH.

Beaumarchais.—LE BARBIER DE SEVILLE. Edited, with Introduction and Notes, by L. P. BLOUET, Assistant Master in St. Paul's School. Fcap. 8vo. 3s. 6d.

Bowen.—FIRST LESSONS IN FRENCH. By H. COURTHOPE BOWEN, M.A., Principal of the Finsbury Training College for Higher and Middle Schools. Extra fcap. 8vo. 1s.

Breymann.—Works by HERMANN BREYMAN, Ph.D., Professor of Philology in the University of Munich.

A FRENCH GRAMMAR BASED ON PHILOLOGICAL PRINCIPLES. Second Edition. Extra fcap. 8vo. 4s. 6d.

FIRST FRENCH EXERCISE BOOK. Extra fcap. 8vo. 4s. 6d.

SECOND FRENCH EXERCISE BOOK. Extra fcap. 8vo. 2s. 6d.

Fasnacht.—Works by G. EUGÈNE FASNACHT, Author of "Macmillan's Progressive French Course," Editor of "Macmillan's Foreign School Classics," &c.

THE ORGANIC METHOD OF STUDYING LANGUAGES.

Extra fcap. 8vo. I. French. 3s. 6d.

A SYNTHETIC FRENCH GRAMMAR FOR SCHOOLS.

Crown 8vo. 3s. 6d.

GRAMMAR AND GLOSSARY OF THE FRENCH LANGUAGE OF THE SEVENTEENTH CENTURY. Crown

8vo.

[*In preparation.*]

Macmillan's Primary Series of French and German Reading Books.—Edited by G. EUGÈNE FASNACHT, Assistant-Master in Westminster School. With Illustrations. Globe 8vo.

DE MAISTRE—LA JEUNE SIBÉRIENNE ET LE LÉPREUX DE LA CITÉ D'AOSTE. Edited, with Introduction, Notes, and Vocabulary. By STEPHANE BARLET, B.Sc. Univ. Gall. and London; Assistant-Master at the Mercers' School, Examiner to the College of Preceptors, the Royal Naval College, &c. 1s. 6d.

GRIMM—KINDER UND HAUSMÄRCHEN. Selected and Edited, with Notes, and Vocabulary, by G. E. FASNACHT. 2s.

HAUFF.—DIE KARAVANE. Edited, with Notes and Vocabulary, by HERMAN HAGER, Ph.D. Lecturer in the Owens College, Manchester. 2s. 6d.

LA FONTAINE—A SELECTION OF FABLES. Edited, with Introduction, Notes, and Vocabulary, by L. M. MORIARTY, B.A., Professor of French in King's College, London. 2s.

PERRAULT—CONTES DE FÉES. Edited, with Introduction, Notes, and Vocabulary, by G. E. FASNACHT. 1s.

G. SCHWAB—ODYSSEUS. With Introduction, Notes, and Vocabulary, by the same Editor. [*In preparation.*]

Macmillan's Progressive French Course.—By G. EUGÈNE FASNACHT, Assistant-Master in Westminster School.

I.—FIRST YEAR, containing Easy Lessons on the Regular Accidence. Extra fcap. 8vo. 1s.

II.—SECOND YEAR, containing an Elementary Grammar with copious Exercises, Notes, and Vocabulary. A new Edition, enlarged and thoroughly revised. Extra fcap. 8vo. 2s.

III.—THIRD YEAR, containing a Systematic Syntax, and Lessons in Composition. Extra fcap. 8vo. 2s. 6d.

THE TEACHER'S COMPANION TO MACMILLAN'S PROGRESSIVE FRENCH COURSE. With Copious Notes, Hints for Different Renderings, Synonyms, Philological Remarks, &c. By G. E. FASNACHT. Globe 8vo. *Second Year* 4s. 6d. *Third Year* 4s. 6d.

Macmillan's Progressive French Readers. By G. EUGÈNE FASNACHT.

- I.—FIRST YEAR, containing Fables, Historical Extracts, Letters, Dialogues, Ballads, Nursery Songs, &c., with Two Vocabularies : (1) in the order of subjects ; (2) in alphabetical order. Extra fcap. 8vo. 2s. 6d.
- II.—SECOND YEAR, containing Fiction in Prose and Verse, Historical and Descriptive Extracts, Essays, Letters, Dialogues, &c. Extra fcap. 8vo. 2s. 6d.

Macmillan's Foreign School Classics. Edited by G. EUGÈNE FASNACHT. 18mo.

FRENCH.

- CORNEILLE—LE CID. Edited by G. E. FASNACHT. 1s.
- DUMAS—LES DEMOISELLES DE ST. CYR. Edited by VICTOR OGER, Lecturer in University College, Liverpool. 1s. 6d.
- LA FONTAINE'S FABLES. Books I.—VI. Edited by L. M. MORIARTY, B.A., Professor of French in King's College, London. [*In preparation.*]
- MOLIÈRE—L'AVARE. By the same Editor. 1s.
- MOLIÈRE—LE BOURGEOIS GENTILHOMME. By the same Editor. 1s. 6d.
- MOLIÈRE—LES FEMMES SAVANTES. By G. E. FASNACHT. 1s.
- MOLIÈRE—LE MISANTHROPE. By the same Editor. 1s.
- MOLIÈRE—LE MÉDECIN MALGRE LUI. By the same Editor. 1s.
- RACINE—BRITANNICUS. Edited by EUGÈNE PELLISSIER, Assistant-Master in Clifton College, and Lecturer in University College, Bristol. 2s.
- FRENCH READINGS FROM ROMAN HISTORY. Selected from Various Authors and Edited by C. COLBECK, M.A., late Fellow of Trinity College, Cambridge ; Assistant-Master at Harrow. 4s. 6d.
- SAND, GEORGE—LA MARE AU DIABLE. Edited by W. E. RUSSELL, M.A., Assistant Master in Haileybury College. 1s.
- SANDEAU, JULES—MADEMOISELLE DE LA SEIGLIÈRE. Edited by H. C. STEEL, Assistant Master in Winchester College. 1s. 6d.
- THIERS'S HISTORY OF THE EGYPTIAN EXPEDITION. Edited by Rev. H. A. BULL, M.A. Assistant-Master in Wellington College. [*In preparation.*]
- VOLTAIRE—CHARLES XII. Edited by G. E. FASNACHT. 3s. 6d.

. Other volumes to follow.

(See also *German Authors*, page 65.)

Masson (Gustave).—A COMPENDIOUS DICTIONARY OF THE FRENCH LANGUAGE (French-English and English-French). Adapted from the Dictionaries of Professor ALFRED ELWALL. Followed by a List of the Principal Diverging Derivations, and preceded by Chronological and Historical Tables. By GUSTAVE MASSON, Assistant Master and Librarian, Harrow School. New Edition. Crown 8vo. 6s.

Molière.—LE MALADE IMAGINAIRE. Edited, with Introduction and Notes, by FRANCIS TARVER, M.A., Assistant Master at Eton. Fcap. 8vo. 2s. 6d.

(See also *Macmillan's Foreign School Classics.*)

Pellissier.—FRENCH ROOTS AND THEIR FAMILIES. A Synthetic Vocabulary, based upon Derivations, for Schools and Candidates for Public Examinations. By EUGÈNE PELLISSIER, M.A., B.Sc., LL.B., Assistant Master at Clifton College, Lecturer at University College, Bristol. Globe 8vo. 6s.

GERMAN.

Huss.—A SYSTEM OF ORAL INSTRUCTION IN GERMAN, by means of Progressive Illustrations and Applications of the leading Rules of Grammar. By HERMANN C. O. HUSS, Ph.D. Crown 8vo. 5s.

Macmillan's Progressive German Course. By G. EUGÈNE FASNACHT.

PART I.—FIRST YEAR. Easy Lessons and Rules on the Regular Accidence. Extra fcap. 8vo. 1s. 6d.

Part II.—SECOND YEAR. Conversational Lessons in Systematic Accidence and Elementary Syntax. With Philological Illustrations and Etymological Vocabulary. New Edition, enlarged and thoroughly recast. Extra fcap. 8vo. 3s. 6d.

Part III.—THIRD YEAR.

[*In preparation.*]
TEACHER'S COMPANION TO MACMILLAN'S PROGRESSIVE GERMAN COURSE. With copious Notes, Hints for Different Renderings, Synonyms, Philological Remarks, &c. By G. E. FASNACHT. Extra Fcap. 8vo. FIRST YEAR. 4s. 6d.

SECOND YEAR. 4s. 6d.

Macmillan's Progressive German Readers. By G. E. FASNACHT.

I.—FIRST YEAR, containing an Introduction to the German order of Words, with Copious Examples, extracts from German Authors in Prose and Poetry; Notes, and Vocabularies. Extra Fcap. 8vo., 2s. 6d.

Macmillan's Primary German Reading Books.

(See page 62.)

Macmillan's Foreign School Classics. - Edited by
G. EUGÈNE FASNACHT, 18mo.

GERMAN.

FREYTAG (G.).—DOKTOR LUTHER. Edited by FRANCIS STORR, M.A., Head Master of the Modern Side, Merchant Taylors' School. [In preparation.]

GOETHE—GOTZ VON BERLICHINGEN. Edited by H. A. BULL, M.A., Assistant Master at Wellington College. 2s.

GOETHE—FAUST. PART I., followed by an Appendix on PART II. Edited by JANE LEE, Lecturer in German Literature at Newnham College, Cambridge. 4s. 6d.

HEINE—SELECTIONS FROM THE REISEBILDER AND OTHER PROSE WORKS. Edited by C. COLBECK, M.A., Assistant-Master at Harrow, late Fellow of Trinity College, Cambridge. 2s. 6d.

LESSING.—MINNA VON BARNHELM. Edited by JAMES SIME. [In preparation.]

SCHILLER—SELECTIONS FROM SCHILLER'S LYRICAL POEMS. Edited, with Notes and a Memoir of Schiller, by E. J. TURNER, B.A., and E. D. A. MORSHEAD, M.A. Assistant-Masters in Winchester College. 2s. 6d.

SCHILLER—DIE JUNGFAU VON ORLEANS. Edited by JOSEPH GOSTWICK. 2s. 6d.

SCHILLER—MARIA STUART. Edited by C. SHELDON, M.A., D.Lit., of the Royal Academical Institution, Belfast. 2s. 6d.

SCHILLER—WILHELM TELL. Edited by G. E. FASNACHT. [In the press.]

SCHILLER.—WALLENSTEINS LAGER. Edited by H. B. COTTERILL, M.A. [In the press.]

UHLAND—SELECT BALLADS. Adapted as a First Easy Reading Book for Beginners. With Vocabulary. Edited by G. E. FASNACHT. 1s.

*** Other Volumes to follow.*

(See also *French Authors*, page 63.)

Pyloodet.—NEW GUIDE TO GERMAN CONVERSATION; containing an Alphabetical List of nearly 800 Familiar Words; followed by Exercises; Vocabulary of Words in frequent use; Familiar Phrases and Dialogues; a Sketch of German Literature, Idiomatic Expressions, &c. By L. PYLODET. 18mo, cloth limp. 2s. 6d.

Whitney.—Works by W. D. WHITNEY, Professor of Sanskrit and Instructor in Modern Languages in Yale College.

A COMPENDIOUS GERMAN GRAMMAR. Crown 8vo. 4s. 6d.

A GERMAN READER IN PROSE AND VERSE. With Notes and Vocabulary. Crown 8vo. 5s.

Whitney and Edgren.—A COMPENDIOUS GERMAN AND ENGLISH DICTIONARY, with Notation of Correspondences and Brief Etymologies. By Professor W. D. WHITNEY, assisted by A. H. EDGREN. Crown 8vo. 7s. 6d.

THE GERMAN-ENGLISH PART, separately, 5s.

MODERN GREEK.

Vincent and Dickson.—HANDBOOK TO MODERN GREEK. By EDGAR VINCENT and T. G. DICKSON, M.A. Second Edition, revised and enlarged, with Appendix on the relation of Modern and Classical Greek by Professor JEBB. Crown 8vo. 6s.

ITALIAN.

Dante.—THE PURGATORY OF DANTE. Edited, with Translation and Notes, by A. J. BUTLER, M.A., late Fellow of Trinity College, Cambridge. Crown 8vo. 12s. 6d.

THE PARADISO OF DANTE. Edited, with Translation and Notes, by the same Author. Crown 8vo. 12s. 6d.

DOMESTIC ECONOMY.

Barker.—FIRST LESSONS IN THE PRINCIPLES OF COOKING. By LADY BARKER. New Edition 18mo. 1s.

Berners.—FIRST LESSONS ON HEALTH. By J. BERNERS. New Edition. 18mo. 1s.

Fawcett.—TALES IN POLITICAL ECONOMY. By MILLICENT GARRETT FAWCETT. Globe 8vo. 3s.

Frederick.—HINTS TO HOUSEWIVES ON SEVERAL POINTS, PARTICULARLY ON THE PREPARATION OF ECONOMICAL AND TASTEFUL DISHES. By Mrs. FREDERICK. Crown 8vo. 1s.

"This unpretending and useful little volume distinctly supplies a desideratum The author steadily keeps in view the simple aim of 'making every-day meals at home, particularly the dinner, attractive,' without adding to the ordinary household expenses."—SATURDAY REVIEW.

Grand'homme.—CUTTING-OUT AND DRESSMAKING. From the French of Mdlle. E. GRAND'HOMME. With Diagrams. 18mo. 1s.

Jex-Blake.—THE CARE OF INFANTS. A Manual for Mothers and Nurses. By SOPHIA JEX-BLAKE, M.D., Member of the Irish College of Physicians; Lecturer on Hygiene at the London School of Medicine for Women. 18mo. 1s.

Tegetmeier.—HOUSEHOLD MANAGEMENT AND COOKERY. With an Appendix of Recipes used by the Teachers of the National School of Cookery. By W. B. TEGETMEIER. Compiled at the request of the School Board for London. 18mo. 1s.

Thornton.—FIRST LESSONS IN BOOK-KEEPING. By J. THORNTON. New Edition. Crown 8vo. 2s. 6d.

The object of this volume is to make the theory of Book-keeping sufficiently plain for even children to understand it.

A Key to the above is in the press.

Wright.—THE SCHOOL COOKERY-BOOK. Compiled and Edited by C. E. GUTHRIE WRIGHT, Hon Sec. to the Edinburgh School of Cookery. 18mo. 1s.

ART AND KINDRED SUBJECTS.

Anderson.—LINEAR PERSPECTIVE, AND MODEL DRAWING. A School and Art Class Manual, with Questions and Exercises for Examination, and Examples of Examination Papers. By LAURENCE ANDERSON. With Illustrations. Royal 8vo. 2s.

Collier.—A PRIMER OF ART. With Illustrations. By JOHN COLLIER. 18mo. 1s.

Delamotte.—A BEGINNER'S DRAWING BOOK. By P. H. DELAMOTTE, F.S.A. Progressively arranged. New Edition improved. Crown 8vo. 3s. 6d.

Ellis.—SKETCHING FROM NATURE. A Handbook for Students and Amateurs. By TRISTRAM J. ELLIS. With a Frontispiece and Ten Illustrations, by H. STACY MARKS, R.A., and Twenty-seven Sketches by the Author. Crown 8vo. 2s. 6d.

Hunt.—TALKS ABOUT ART. By WILLIAM HUNT. With a Letter from Sir J. E. MILLAIS, Bart., R.A. Crown 8vo. 3s. 6d.

Taylor.—A PRIMER OF PIANOFORTE PLAYING. By FRANKLIN TAYLOR. Edited by Sir GEORGE GROVE. 18mo. 1s.

WORKS ON TEACHING.

Blakiston.—THE TEACHER. Hints on School Management. A Handbook for Managers, Teachers' Assistants, and Pupil Teachers. By J. R. BLAKISTON, M.A. Crown 8vo. 2s. 6d. (Recommended by the London, Birmingham, and Leicester School Boards.)

"Into a comparatively small book he has crowded a great deal of exceedingly useful and sound advice. It is a plain, common-sense book, full of hints to the teacher on the management of his school and his children."—SCHOOL BOARD CHRONICLE.

Calderwood.—ON TEACHING. By Professor HENRY CALDERWOOD. New Edition. Extra fcap. 8vo. 2s. 6d.

Carter.—EYESIGHT IN SCHOOLS. A Paper read before the Association of Medical Officers of Schools on April 15th, 1885. By R. BRUDENELL CARTER, F.R.C.S., Ophthalmic Surgeon to St. George's Hospital. Crown 8vo. Sewed. 1s.

Fearon.—SCHOOL INSPECTION. By D. R. FEARON, M.A., Assistant Commissioner of Endowed Schools. New Edition. Crown 8vo. 2s. 6d.

Gladstone.—OBJECT TEACHING. A Lecture delivered at the Pupil-Teacher Centre, William Street Board School, Hammersmith. By J. H. GLADSTONE, Ph.D., F.R.S., Member of the London School Board. With an Appendix. Crown 8vo. 3d.

"It is a short but interesting and instructive publication, and our younger teachers will do well to read it carefully and thoroughly. There is much in these few pages which they can learn and profit by."—THE SCHOOL GUARDIAN.

Hertel.—OVERPRESSURE IN HIGH SCHOOLS IN DENMARK. By Dr. HERTEL, Municipal Medical Officer, Copenhagen. Translated from the Danish by C. GODFREY SØRENSEN. With Introduction by Sir J. CRICHTON-BROWNE, M.D., LL.D., F.R.S. Crown 8vo. 3s. 6d.

DIVINITY.

* * For other Works by these Authors, see THEOLOGICAL CATALOGUE.

Abbott (Rev. E. A.)—BIBLE LESSONS. By the Rev. E. A. ABBOTT, D.D., Head Master of the City of London School. New Edition. Crown 8vo. 4s. 6d.

"Wise, suggestive, and really profound initiation into religious thought."—GUARDIAN.

Abbott—Rushbrooke.—THE COMMON TRADITION OF THE SYNOPTIC GOSPELS, in the Text of the Revised Version. By EDWIN A. ABBOTT, D.D., formerly Fellow of St. John's College, Cambridge, and W. G. RUSHBROOKE, M.L., formerly Fellow of St. John's College, Cambridge. Crown 8vo. 3s. 6d.

The Acts of the Apostles.—Being the Greek Text as revised by Professors WESTCOTT and HORT. With Explanatory Notes for the Use of Schools, by T. E. PAGE, M.A., late Fellow of St. John's College, Cambridge; Assistant Master at the Charterhouse. Fcap. 8vo. 4s. 6d.

Arnold.—A BIBLE-READING FOR SCHOOLS.—THE GREAT PROPHECY OF ISRAEL'S RESTORATION (Isaiah, Chapters xl.—lxvi.). Arranged and Edited for Young Learners. By MATTHEW ARNOLD, D.C.L., formerly Professor of Poetry in the University of Oxford, and Fellow of Oriel. New Edition. 18mo, cloth. 1s.

- Arnold.**—ISAIAH XL.—LXVI. With the Shorter Prophecies allied to it. Arranged and Edited, with Notes, by MATTHEW ARNOLD. Crown 8vo. 5s.
- ISAIAH OF JERUSALEM, IN THE AUTHORISED ENGLISH VERSION. With Introduction, Corrections, and Notes. By MATTHEW ARNOLD. Crown 8vo. 4s. 6d.
- Benham.**—A COMPANION TO THE LECTIONARY. Being a Commentary on the Proper Lessons for Sundays and Holy Days. By Rev. W. BENHAM, B.D., Rector of S. Edmund with S. Nicholas Acons, &c New Edition. Crown 8vo. 4s. 6d.
- Calvert.**—GREEK TESTAMENT, School Readings in the. A Course of thirty-six Lessons mainly following upon the Narrative of St. Mark. Edited and Arranged with Introduction, Notes and Vocabulary, by the Rev. A. CALVERT, M.A., late Fellow of St. John's College, Cambridge. Fcap. 8vo. [*In the press.*]
- Cassel.**—MANUAL OF JEWISH HISTORY AND LITERATURE; preceded by a BRIEF SUMMARY OF BIBLE HISTORY. By DR. D. CASSEL. Translated by Mrs. HENRY LUCAS. Fcap. 8vo. 2s. 6d.
- Cheetham.**—A CHURCH HISTORY OF THE FIRST SIX CENTURIES. By the Ven. ARCHDEACON CHEETHAM, Crown 8vo. [*In the press.*]
- Cross.**—BIBLE READINGS SELECTED FROM THE PENTATEUCH AND THE BOOK OF JOSHUA. By the Rev. JOHN A. CROSS. Globe 8vo. 2s. 6d.
- Curteis.**—MANUAL OF THE THIRTY-NINE ARTICLES. By G. H. CURTEIS, M.A., Principal of the Lichfield Theological College. [*In preparation*]
- Davies.**—THE EPISTLES OF ST. PAUL TO THE EPHESIANS, THE COLOSSIANS, AND PHILEMON; with Introductions and Notes, and an Essay on the Traces of Foreign Elements in the Theology of these Epistles. By the Rev. J. LLEWELYN DAVIES, M.A., Rector of Christ Church, St. Marylebone; late Fellow of Trinity College, Cambridge. Second Edition. Demy 8vo. 7s. 6d.
- Drummond.**—THE STUDY OF THEOLOGY, INTRODUCTION TO. By JAMES DRUMMOND, LL.D., Professor of Theology in Manchester New College, London. Crown 8vo. 5s.
- Gaskoin.**—THE CHILDREN'S TREASURY OF BIBLE STORIES. By Mrs. HERMAN GASKOIN. Edited with Preface by Rev. G. F. MACLEAR, D.D. PART I.—OLD TESTAMENT HISTORY. 18mo. 1s. PART II.—NEW TESTAMENT. 18mo. 1s. PART III.—THE APOSTLES: ST. JAMES THE GREAT, ST. PAUL, AND ST JOHN THE DIVINE. 18mo. 1s.

Golden Treasury Psalter.—Students' Edition. Being an Edition of "The Psalms Chronologically arranged, by Four Friends," with briefer Notes. 18mo. 3s. 6d.

Greek Testament.—Edited, with Introduction and Appendices, by CANON WESTCOTT and Dr. F. J. A. HORT. Two Vols. Crown 8vo. 10s. 6d. each.

Vol. I. The Text.

Vol. II. Introduction and Appendix.

Greek Testament.—Edited by Canon WESTCOTT and Dr. HORT. School Edition of Text. 12mo. cloth. 4s. 6d. 18mo. roan, red edges. 5s. 6d.

SCHOOL READINGS IN. A Course of Thirty-Six Lessons, mainly following upon the Narrative of St. Mark. Edited and Arranged, with Introduction, Notes, and Vocabulary, by Rev. A. CALVERT, M.A., late Fellow of St. John's College, Cambridge. Fcap. 8vo.

[Immediately.]

THE ACTS OF THE APOSTLES. Being the Greek Text as revised by Drs. WESTCOTT and HORT. With Explanatory Notes by T. E. PAGE, M.A., Assistant Master at the Charterhouse. Fcap. 8vo. 4s. 6d.

THE GOSPEL ACCORDING TO ST. MARK. Being the Greek Text as revised by Drs. WESTCOTT and HORT. With Explanatory Notes by Rev. J. O. F. MURRAY, M.A., Lecturer in Emmanuel College, Cambridge. Fcap. 8vo.

[In preparation.]

Hardwick.—Works by Archdeacon HARDWICK:—

A HISTORY OF THE CHRISTIAN CHURCH. Middle Age. From Gregory the Great to the Excommunication of Luther. Edited by WILLIAM STUBBS, M.A., Regius Professor of Modern History in the University of Oxford. With Four Maps. New Edition. Crown 8vo. 10s. 6d.

A HISTORY OF THE CHRISTIAN CHURCH DURING THE REFORMATION. Eighth Edition. Edited by Professor STUBBS. Crown 8vo. 10s. 6d.

Jennings and Lowe.—**THE PSALMS, WITH INTRODUCTIONS AND CRITICAL NOTES.** By A. C. JENNINGS, M.A.; assisted in parts by W. H. LOWE, M.A. In 2 vols. Second Edition Revised. Crown 8vo. 10s. 6d. each.

Kuenen.—**PENTATEUCH AND BOOK OF JOSHUA:** an Historico-Critical Inquiry into the Origin and Composition of the Hexateuch. By A. KUENEN, Professor of Theology at Leiden. Translated from the Dutch, with the assistance of the Author, by PHILLIP H. WICKSTEED, M.A. 8vo. 14s.

The OXFORD MAGAZINE says:—"The work is absolutely indispensable to all special students of the Old Testament."

Lightfoot.—Works by the Right Rev. J. B. LIGHTFOOT, D.D., D.C.L., LL.D., Lord Bishop of Durham.

ST. PAUL'S EPISTLE TO THE GALATIANS. A Revised Text, with Introduction, Notes, and Dissertations. Ninth Edition, revised. 8vo. 12s.

ST. PAUL'S EPISTLE TO THE PHILIPPIANS. A Revised Text, with Introduction, Notes, and Dissertations. Ninth Edition, revised. 8vo. 12s.

ST. CLEMENT OF ROME—THE TWO EPISTLES TO THE CORINTHIANS. A Revised Text, with Introduction and Notes. 8vo. 8s. 6d.

ST. PAUL'S EPISTLES TO THE COLOSSIANS AND TO PHILEMON. A Revised Text, with Introductions, Notes, and Dissertations. Eighth Edition, revised. 8vo. 12s.

THE APOSTOLIC FATHERS. Part II. S. IGNATIUS—S. POLYCARP. Revised Texts, with Introductions, Notes, Dissertations, and Translations. 2 volumes in 3. Demy 8vo. 48s.

Maclear.—Works by the Rev. G. F. MACLEAR, D.D., Canon of Canterbury, Warden of St. Augustine's College, Canterbury, and late Head-Master of King's College School, London:—

A CLASS-BOOK OF OLD TESTAMENT HISTORY. New Edition, with Four Maps. 18mo. 4s. 6d.

A CLASS-BOOK OF NEW TESTAMENT HISTORY, including the Connection of the Old and New Testaments. With Four Maps. New Edition. 18mo. 5s. 6d.

A SHILLING BOOK OF OLD TESTAMENT HISTORY, for National and Elementary Schools. With Map. 18mo, cloth. New Edition.

A SHILLING BOOK OF NEW TESTAMENT HISTORY, for National and Elementary Schools. With Map. 18mo, cloth. New Edition.

These works have been carefully abridged from the Author's large manuals.

CLASS-BOOK OF THE CATECHISM OF THE CHURCH OF ENGLAND. New Edition. 18mo. 1s. 6d.

A FIRST CLASS-BOOK OF THE CATECHISM OF THE CHURCH OF ENGLAND. With Scripture Proofs, for Junior Classes and Schools. New Edition. 18mo. 6d.

A MANUAL OF INSTRUCTION FOR CONFIRMATION AND FIRST COMMUNION. WITH PRAYERS AND DEVOTIONS. 32mo, cloth extra, red edges. 2s.

Maurice.—THE LORD'S PRAYER, THE CREED, AND THE COMMANDMENTS. A Manual for Parents and Schoolmasters. To which is added the Order of the Scriptures. By the Rev. F. DENISON MAURICE, M.A. 18mo, cloth, limp. 1s.

Pentateuch and Book of Joshua : an Historico-Critical Inquiry into the Origin and Composition of the Hexateuch. By A. KUENEN, Professor of Theology at Leiden. Translated from the Dutch, with the assistance of the Author, by PHILIP H. WICKSTEED, M.A. 8vo. 14s.

Procter.—A HISTORY OF THE BOOK OF COMMON PRAYER, with a Rationale of its Offices. By Rev. F. PROCTER. M.A. Seventeenth Edition, revised and enlarged. Crown 8vo. 10s. 6d.

Procter and Maclear.—AN ELEMENTARY INTRODUCTION TO THE BOOK OF COMMON PRAYER. Rearranged and supplemented by an Explanation of the Morning and Evening Prayer and the Litany. By the Rev. F. PROCTER and the Rev. Dr. MACLEAR. New and Enlarged Edition, containing the Communion Service and the Confirmation and Baptismal Offices. 18mo. 2s. 6d.

The Psalms, with Introductions and Critical Notes.—By A. C. JENNINGS, M.A., Jesus College, Cambridge, Tyrwhitt Scholar, Crosse Scholar, Hebrew University Prizeman, and Fry Scholar of St. John's College, Carus and Scholefield Prizeman, Vicar of Whittlesford, Cambs.; assisted in Parts by W. H. LOWE, M.A., Hebrew Lecturer and late Scholar of Christ's College, Cambridge, and Tyrwhitt Scholar. In 2 vols. Second Edition Revised. Crown 8vo. 10s. 6d. each.

Ramsay.—THE CATECHISER'S MANUAL; or, the Church Catechism Illustrated and Explained, for the Use of Clergymen, Schoolmasters, and Teachers. By the Rev. ARTHUR RAMSAY, M.A. New Edition. 18mo. 1s. 6d.

Ryle.—AN INTRODUCTION TO THE CANON OF THE OLD TESTAMENT. By Rev. H. E. RYLE, M.A., Fellow of King's College, Cambridge, and Principal of St. David's College, Lampeter. Crown 8vo. [In preparation.]

St. John's Epistles.—The Greek Text with Notes and Essays, by BROOKE FOSS WESTCOTT, D.D., Regius Professor of Divinity and Fellow of King's College, Cambridge, Canon of Westminster, &c. Second Edition Revised. 8vo. 12s. 6d.

St. Paul's Epistles.—Greek Text, with Introduction and Notes.

THE EPISTLE TO THE GALATIANS. Edited by the Right Rev. J. B. LIGHTFOOT, D.D., Bishop of Durham. Ninth Edition. 8vo. 12s.

THE EPISTLE TO THE PHILIPPIANS. By the same Editor, Ninth Edition. 8vo. 12s.

St. Paul's Epistles (*continued*)—

THE EPISTLE TO THE COLOSSIANS AND TO PHILEMON. By the same Editor. Eighth Edition. 8vo. 12s.

THE EPISTLE TO THE ROMANS. Edited by the Very Rev. C. J. VAUGHAN, D.D., Dean of Llandaff, and Master of the Temple. Fifth Edition. Crown 8vo. 7s. 6d.

THE EPISTLE TO THE PHILIPPIANS, with Translation, Paraphrase, and Notes for English Readers. By the same Editor. Crown 8vo. 5s.

THE EPISTLE TO THE THESSALONIANS, COMMENTARY ON THE GREEK TEXT. By JOHN EADIE, D.D., LL.D. Edited by the Rev. W. YOUNG, M.A., with Preface by Professor CAIRNS. 8vo. 12s.

THE EPISTLES TO THE EPHESIANS, THE COLOSSIANS, AND PHILEMON; with Introductions and Notes, and an Essay on the Traces of Foreign Elements in the Theology of these Epistles. By the Rev. J. LLEWELYN DAVIES, M.A., Rector of Christ Church, St. Marylebone; late Fellow of Trinity College, Cambridge. Second Edition, revised. Demy 8vo. 7s. 6d.

The Epistle to the Hebrews. In Greek and English. With Critical and Explanatory Notes. Edited by Rev. FREDERIC RENDALL, M.A., formerly Fellow of Trinity College, Cambridge, and Assistant-Master at Harrow School. Crown 8vo. 6s.

The Epistle to the Hebrews. The Greek Text with Notes and Essays by B. F. WESTCOTT, D.D. 8vo. [*In the press.*]

Westcott.—Works by BROOKE FOSS WESTCOTT, D.D., Canon of Westminster, Regius Professor of Divinity, and Fellow of King's College, Cambridge.

A GENERAL SURVEY OF THE HISTORY OF THE CANON OF THE NEW TESTAMENT DURING THE FIRST FOUR CENTURIES. Sixth Edition. With Preface on "Supernatural Religion." Crown 8vo. 10s. 6d.

INTRODUCTION TO THE STUDY OF THE FOUR GOSPELS. Sixth Edition. Crown 8vo. 10s. 6d.

THE BIBLE IN THE CHURCH. A Popular Account of the Collection and Reception of the Holy Scriptures in the Christian Churches. New Edition. 18mo, cloth. 4s. 6d.

THE EPISTLES OF ST. JOHN. The Greek Text, with Notes and Essays. Second Edition Revised. 8vo. 12s. 6d.

THE EPISTLE TO THE HEBREWS. The Greek Text Revised, with Notes and Essays. 8vo. [*In the press.*]

SOME THOUGHTS FROM THE ORDINAL. Cr. 8vo. 1s. 6d.

Westcott and Hort.—THE NEW TESTAMENT IN THE ORIGINAL GREEK. The Text Revised by B. F. WESTCOTT, D.D., Regius Professor of Divinity, Canon of Westminster, and F. J. A. HORT, D.D., Hulsean Professor of Divinity; Fellow of Emmanuel College, Cambridge: late Fellows of Trinity College, Cambridge. 2 vols. Crown 8vo. 10s. 6d. each.

Vol. I. Text.

Vol. II. Introduction and Appendix.

THE NEW TESTAMENT IN THE ORIGINAL GREEK, FOR SCHOOLS. The Text Revised by BROOKE FOSS WESTCOTT, D.D., and FENTON JOHN ANTHONY HORT, D.D. 12mo. cloth. 4s. 6d. 18mo. roan, red edges. 5s. 6d.

Wilson.—THE BIBLE STUDENT'S GUIDE to the more Correct Understanding of the English Translation of the Old Testament, by reference to the original Hebrew. By WILLIAM WILSON, D.D., Canon of Winchester, late Fellow of Queen's College, Oxford. Second Edition, carefully revised. 4to. cloth. 25s.

Wright.—THE BIBLE WORD-BOOK: A Glossary of Archaic Words and Phrases in the Authorised Version of the Bible and the Book of Common Prayer. By W. ALDIS WRIGHT, M.A., Fellow and Bursar of Trinity College, Cambridge. Second Edition, Revised and Enlarged. Crown 8vo. 7s. 6d.

Yonge (Charlotte M.).—SCRIPTURE READINGS FOR SCHOOLS AND FAMILIES. By CHARLOTTE M. YONGE. Author of "The Heir of Redclyffe." In Five Vols.

FIRST SERIES. GENESIS TO DEUTERONOMY. Extra fcap. 8vo. 1s. 6d. With Comments, 3s. 6d.

SECOND SERIES. From JOSHUA to SOLOMON. Extra fcap. 8vo. 1s. 6d. With Comments, 3s. 6d.

THIRD SERIES. The KINGS and the PROPHETS. Extra fcap. 8vo. 1s. 6d. With Comments, 3s. 6d.

FOURTH SERIES. The GOSPEL TIMES. 1s. 6d. With Comments. Extra fcap. 8vo, 3s. 6d.

FIFTH SERIES. APOSTOLIC TIMES. Extra fcap. 8vo. 1s. 6d. With Comments, 3s. 6d.

Zechariah—Lowe.—THE HEBREW STUDENT'S COMMENTARY ON ZECHARIAH, HEBREW AND LXX. With Excursus on Syllable-dividing, Metheg, Initial Dagesh, and Siman Rapheh. By W. H. LOWE, M.A., Hebrew Lecturer at Christ's College, Cambridge. Demy 8vo. 10s. 6d.

"These excellent biographies should be made class-books for schools."
—*Westminster Review*.

POPULAR EDITION, ONE SHILLING EACH.

Now Publishing in Monthly Volumes (Volume I., January, 1887),
price One Shilling each in Paper Cover, or in Limp Cloth
Binding, Eighteenpence.

English Men of Letters

Edited by JOHN MORLEY.

"This admirable series."—*The Guardian*.

"Enjoyable and excellent little books."—*Academy*.

JOHNSON.

By LESLIE STEPHEN.

SCOTT.

By R. H. HUTTON.

GIBBON.

By J. C. MORISON.

SHELLEY.

By J. A. SYMONDS.

HUME.

By T. H. HUXLEY, F.R.S.

GOLDSMITH.

By WILLIAM BLACK.

DEFOE.

By W. MINTO.

BURNS.

By Principal SHAIRP.

SPENSER.

By the Very Rev. the DEAN OF
ST. PAUL'S.

THACKERAY.

By ANTHONY TROLLOPE.

BURKE.

By JOHN MORLEY.

MILTON.

By MARK PATTISON.

HAWTHORNE.

By HENRY JAMES.

SOUTHEY.

By Professor DOWDEN.

BUNYAN.

By J. A. FROUDE.

CHAUCER.

By Professor A. W. WARD.

COWPER.

By GOLDWIN SMITH.

POPE.

By LESLIE STEPHEN.

BYRON.

By Professor NICHOL.

DRYDEN.

By G. SAINTSBURY.

LOCKE.

By THOMAS FOWLER.

WORDSWORTH.

By F. W. H. MYERS.

LANDOR.

By SIDNEY COLVIN.

DE QUINCEY.

By Professor MASSON.

CHARLES LAMB.

By Rev. A. AINGER.

BENTLEY.

By Professor R. C. JEBB.

DICKENS.

By Professor A. W. WARD.

GRAY.

By EDMUND GOSSE.

SWIFT.

By LESLIE STEPHEN.

STERNE.

By H. D. TRAILL.

MACAULAY.

By J. C. MORISON.

FIELDING.

By AUSTIN DOBSON.

SHERIDAN.

By Mrs. OLIPHANT.

ADDISON.

By W. J. COURTHOPE.

BACON.

By the Very Rev. the DEAN OF
ST. PAUL'S.

COLERIDGE.

By H. D. TRAILL.

* * Other Volumes to follow.

MACMILLAN AND CO. LONDON.

MACMILLAN'S GLOBE LIBRARY.

PRICE 3s. 6d. EACH.

SHAKESPEARE'S COMPLETE WORKS.

Edited by W. G. CLARK, M.A., and W. ALDIS WRIGHT, M.A.

MORTE D'ARTHUR. The Book of King Arthur and of His Noble Knights of the Round Table. Original Edition of Caxton revised for modern use, with Notes, &c. By Sir E. STRACHEY.

ROBINSON CRUSOE. Edited after the Original Editions. With a Biographical Introduction by HENRY KINGSLEY, F.R.G.S.

SIR WALTER SCOTT'S POETICAL WORKS. Edited, with Biographical and Critical Memoir, by F. T. PALGRAVE.

DRYDEN'S POETICAL WORKS. Edited, with a Memoir, Revised Text, and Notes, by W. D. CHRISTIE, M.A.

COWPER'S POETICAL WORKS. Edited, with Biographical Introduction and Notes, by Rev. W. BENHAM, B.D.

VIRGIL. Rendered into English Prose by J. LONSDALE, M.A., and S. LEE, M.A.

HORACE. Rendered into English Prose by J. LONSDALE, M.A., and S. LEE, M.A.

BURNS'S COMPLETE WORKS. Edited from the best Printed and MS. Authorities. By ALEXANDER SMITH.

GOLDSMITH'S MISCELLANEOUS WORKS. With Biographical Introduction by Professor MASSON.

POPE'S POETICAL WORKS. Edited, with Notes and Memoir, by Professor WARD, of Owens College.

SPENSER'S COMPLETE WORKS. Edited from the Original Editions and Manuscripts, with Glossary, by R. MORRIS.

MILTON'S POETICAL WORKS. Edited with Introductions and Notes, by Professor MASSON.



